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CONTENTS

	Page
Problems of Scientific Publication	205
South African Botany. By Dr. George Taylor	206
Ethnos and the Modern Age. By Prof. Walter Fitzgerald	208
Introduction to Plato. By Prof. A. D. Ritchie	208
Spectroscopic Study of the Permeability and Lysis of Red Blood Corpuscles. By Prof. D. Keilin, F.R.S., and Dr. E. F. Hartree	210
Climate and Insect Life. By Dr. C. B. Williams	214
Weather and Electric Power Systems. By J. S. Forrest	215
Development of a Chemotherapy for Systemic Arsenical Poisoning. By Dr. J. F. Danielli, Mary Danielli, P. D. Mitchell, L. N. Owen and G. Shaw	217
American Work on BAL	218
Obituaries :	
Sir Farquhar Buzzard, Bart., K.C.V.O. By Prof. H. Cairns	218
Dr. L. Cernosvitov. By Dr. E. Trewavas	219
Dr. Thomas Barbour. By Prof. J. Stanley Gardiner, F.R.S.	220
Dr. E. J. H. Mackay	220
Mr. R. E. Turner. By Robert B. Benson	221
News and Views	221
Letters to the Editors :	
Electrochemistry of Uranium.—H. G. Heal	225
The Clay Minerals Halloysite and Meta-halloysite.—Dr. G. W. Brindley, K. Robinson and Dr. D. M. C. MacEwan	225
Patterson Distributions and Native Protein Crystallography.—Dr. Dorothy Wrinch	226
Total Reflexion in Absorbing Media.—Dr. L. Pincherle	226
Radio-sonde Recording of Potential Gradients.—Dr. K. Kreielsheimer and R. Belin	227
Origin of Ion Burn in Cathode-Ray Tubes.—Dr. G. Liebmann	228
Quenching of Fluorescence by van der Waals Forces.—S. Sambursky and Dr. G. Wolfsohn	228
Methyl Iodide Flame Bands.—R. C. Blake and T. Iredale	229
Entropy and Elasticity in Keratin and Myosin.—H. J. Woods	229
Presence of a Δ^5 Unsaturated Sterol Derivative in the Medulla Cells of Keratin Fibres.—J. L. Stoves	230
Transplantation of Larval Ovaries in *Drosophila* from and to Individuals Susceptible to Carbon Dioxide.—Dr. H. Kalmus and A. N. Mitchison	230
Blood Group A Substances in Commercial Hog Stomach Powder.—M. E. Polan	231
Addition Compounds between Sucrose and the Sodium Halides.—W. Cochran	231
Chemistry and Biochemistry of the Scent Glands of the Beaver (*Castor fiber*).—Edgar Lederer	231
A Substitute for 'Annatto' in Butter.—Dr. Husein Sajd and I. A. A. Nada	232
A Photosensitized Keratitis in Cattle Dosed with Phenothiazine.—L. K. Whitten, N. T. Clare and Daisy B. Filmer	232
Anopheline Life-Cycles and Population Fluctuations.—Major C. R. Ribbands	232
Erosion in the Sudan.—A. L. Howard	233
The British Commonwealth Scientific Office and Non-Governmental Science.—Dr. J. A. V. Butler	233
Academic Scientific Men and Consultants.—Dr. H. E. Cox	233
Physical Methods for the Identification of Materials. By F. A. Bannister	234
Mite-Typhus and the New Mite-Typhus Vaccine. By Dr. G. Lapage	236
Biological Properties of *Bacillus subtilis*. By Dr. H.-R. Olivier	238
Limnology in the U.S.S.R. By S. I. Tomkieff	239
Classification of Mammals. By Sir C. Forster Cooper, F.R.S.	239
Recent Scientific and Technical Books	Supp. II

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PROBLEMS OF SCIENTIFIC PUBLICATION

COMMENCING with this issue, "Letters to the Editors" of *Nature* are being printed in a smaller type than hitherto. This is only a temporary measure, but it is not yet possible to state when it will be possible for the correspondence columns to revert to their original form. Though it is only a temporary measure, it is not a pleasant one ; it is, however, essential for reasons of space and for other very important reasons. It is a symptom of a much wider and equally serious problem. *Nature*, in common with all other journals and periodicals, was compelled, under stress of war conditions, to reduce its size—the number of pages was reduced, the size of page was decreased, and smaller type used in the main part of the journal. Extra supplies of paper were permitted from time to time, but usually on condition that the extra allowance was utilized mainly for increasing the number of copies exported. Thus the position arose that the publishers were able to accept subscriptions from abroad but not from Great Britain. This measure has had its advantages recently, in helping to bring those men of science so long working out of touch with each other back to that international scientific collaboration which *Nature* has always endeavoured to foster. It needs little imagination to realize how starved of intellectual stimulation and scientific information so many of these men of science must have been during the war years.

A few months ago, the general position was apparently changed, in that the restrictions on the mode of use of paper allocated were lifted. But this does not solve the problem which faces the Editors to-day, namely, the need for more space to print the numerous important items awaiting publication, for the paper available was required to meet the increasing demand for copies of the journal. Indeed, the problem itself is probably unique, since *Nature* is essentially a scientific journal.

During the War, the balance of *Nature* was necessarily somewhat upset, since certain branches of science came under the ban of secrecy whereas others did not. But for several reasons this did not reduce the number of contributions to *Nature*, mainly because new interests arose. This journal is not only a scientific newspaper and forum for discussion of scientific research and progress : it also has very much to heart scientific policy, both national and international, and also the relations of science and scientific men to the general community. Science played such a large and important part during the War that scientific policy has therefore had to loom large in the pages of *Nature*.

Another extra demand on *Nature* in recent years has been for space to publish articles which would normally be considered too specialized for publication in a general scientific journal. The Editors, however, have done their best to accommodate such articles because, owing to the War, some of the more special scientific journals, which would have been their natural vehicle, slowed down or even

stopped publication, and, indeed, have yet to resume their important roles. Many such articles would have appeared, at the best, very belatedly, and their main purpose often missed, if an opportunity for their publication had not been afforded by *Nature*.

Now that the War is over, there is a temporary spate of material for publication which can be explained on several grounds. The cloak of secrecy has been discarded in many cases, and much scientific progress made during the War can now be presented to the whole scientific world. This must be carried out as swiftly as possible in order to help science back quickly to its normal routine of full publicity and general discussion. Again, men of science, hitherto unable to communicate with the scientific world outside their own countries, are now able to do so. *Nature* must be made available to them; and above all, facilities must be given for publication of scientific results obtained and conclusions drawn by these workers.

Taking a long-term view of affairs, it may be expected that in the coming months and years the calls on the pages of *Nature* are likely to continue to increase. The war-time work on radar, penicillin, atomic energy, and so on, have forced on the notice of the general public the significance of scientific discovery. As we have emphasized time and again, the results achieved during the War represent but the speeding-up of investigations under the impulse of dire necessity and with the aid of facilities provided almost without limit and question as regards finance, supplies and man-power. Nevertheless, they have made patent to all the power which science must and does exert in our lives, and they suggest the increasing attention which must be given to scientific developments in the years to come. Increasing research and increasing numbers of those engaged directly and indirectly in it mean a growth in the publication of results in order to achieve the full interchange of information so necessary for the cause of progress.

Signs of all this are already appearing in *Nature* office. It is no exaggeration to say that more "Letters to the Editors" and many more general and special articles are awaiting publication in *Nature* now than at any other time in its history; more than two hundred and fifty "letters", from many centres of scientific research throughout the world, are awaiting publication. Books for review, also, are beginning to arrive from those countries until recently cut off from contact with Britain.

The only satisfactory solution to the whole problem would be to increase very considerably the size of the journal. This is out of the question at the moment; but the amount of paper available for *Nature* has just been increased, and will enable us to overtake some of the arrears. It is to be hoped that the period during which space and supply cannot meet the demand will not be long; but while it lasts the problem has to be faced.

Reduction in size of type in the correspondence columns will be a considerable help. But there are certain other aspects which are not so easy of solution. For example, the main aim of the Editors is to facilitate prompt publication. This is not always possible to-day, and each case has to be judged on its merits; consequently, for the time being, some delay is inescapable. It has been suggested that publication should follow strictly according to date of receipt at *Nature* office. This policy has never been followed in *Nature*, neither can it be. *Nature* covers all branches of science, and when deciding what shall be published in any issue the Editors must be guided by several factors—one of which is, of course, date of receipt—otherwise in any one issue either one section or several sections of the journal or perhaps the whole issue would be hopelessly out of proportion.

Readers and contributors can be of assistance during the present difficulty. It is essential that they keep their communications down to the absolute minimum in length. Furthermore, illustrations, graphs and tables should not be included unless they are essential to the argument or unless they render unnecessary a more lengthy amount of text.

As soon as the paper situation permits, the size of *Nature* will be increased and the type and lay-out improved. Until then, every effort will be made to publish everything which the Editors find suitable, even though the form in which it appears may not be so pleasantly readable as they would wish.

SOUTH AFRICAN BOTANY

A Botanist in Southern Africa

By Dr. John Hutchinson. Pp. xii + 686 + 49 plates. (London: P. R. Gawthorn, Ltd., 1946.) 45*s*. net.

THIS important book is primarily an elaboration of the botanical results of the author's travels in southern Africa in 1928 and 1930, though it contains much more than the simple title suggests. Dr. Hutchinson has drawn on his wide knowledge of flowering plants, his long acquaintance with the special problems associated with African (and particularly South African) taxonomy, his keen interest in phytogeography, his artistic ability, and his experience in the field to produce a noteworthy and, in some respects, unique volume.

General Smuts, whose vivid portrait by Prof. Arthur Pan is splendidly reproduced as a frontispiece, contributes an appreciative foreword (revealing, incidentally, his deep understanding of the problems of natural classification) in which he pays tribute to Dr. Hutchinson's earlier systematic work, yet emphasizing the severe limitations of basing such investigations solely on preserved material. "Botany is a science of life, and cannot be learned fully from the dead . . . Hutchinson had still to complete his studies . . . He had studied Africa dead in the Herbarium. He had still to see it living in the sun, on the mountains and the plains, in heat and drought, in rain and swamp, in the shadows and the insolation of this so-called Dark Continent . . . we roamed at will through the floral treasuries of Southern Africa. . . . What fun to present Hutchinson with a live plant which he could not recognize, only to be told that he had determined it dead at Kew!" Now Dr. Hutchinson has the last word and his impressive collections of more than 4,700 specimens, including about fifty new species, a new genus, and many topotypes in confirmation of old records, show how

surely he grasped his opportunities to make a notable contribution to African botanical science.

South Africa must now be regarded as a comparatively well-explored country. It has attracted a succession of botanical and horticultural collectors since the early seventeenth century, and our national collections and, to a lesser extent, our gardens bear witness to their zeal. For some years, too, the energetic and efficient Division of Plant Industry of the Union has been actively engaged in botanical survey work. Nevertheless, Dr. Hutchinson has shown that prizes still await the specialist and keen collector even along the well-beaten tracks. In his limited time, the author had more than his fair share of adventure, real and imaginary, and probably crammed more collecting into his rapid tours than any previous traveller.

The matter of the book is arranged in five parts. In the first, the author deals with the outward voyage (giving brief accounts of the vegetational features of the islands visited and passed), provides a summary of the major floral regions of Africa, and then describes his botanical excursions to various parts of the Cape Province. The chapters in this section contain much of general interest and the discussions on phytogeographical relations are particularly interesting. Dr. Hutchinson is a convinced supporter of the Wegener hypothesis, and certainly the many examples which he quotes, and so usefully illustrates with distributional sketch maps, demonstrate significant affinities between the floras of South America, South Africa, Madagascar, India and Australasia. Yet, in a lengthy quotation from an address by General Smuts (quoted on pp. 134–136), caution is urged against the complete acceptance of the Wegener theory; it is regarded as "a fruitful point of view more than a solution, as a suggestive line of thought and research along which useful work may be done in the future".

Attention may be directed to the induced plant modifications mentioned in Chapter 6. There, Dr. Hutchinson figures two members of the Iridaceæ, *Antholyza ringens* L. and *Gladiolus alatus* L., in which "through the action of sun-birds", plant organs have supposedly become modified as perches for the birds. An interesting example of alleged protective resemblance is described and figured on pp. 165, 167–168. In his travels Dr. Hutchinson noticed that the flower heads in the genus *Arctotis* were commonly attacked by beetles. Later he observed that two or three of the yellow ray florets of *Gorteria diffusa* Thunb., also belonging to the Compositæ, have "a large velvet-like blotch at the base, with two white spots like a pair of eyes near the top of the blotch" resembling the back of the boring beetle. He suggests that these occasional markings on *Gorteria* may be a protection against attack—presumably preventing transference of attack from the *Arctotis* to *Gorteria*. The idea is certainly thought-provoking and raises so many questions that one feels the need for much more evidence and, if possible, experimental data, to substantiate Dr. Hutchinson's ingenious theory.

Parts II and III deal with the further exploration of the Union and Part V describes General Smuts' botanical expedition to Lake Tanganyika. The impression is gained that, throughout, the pace set was too hot for convenient and thorough botanical collecting, and, though the results attest great industry in the field, a more leisurely expedition could scarcely fail to make interesting discoveries. The aquatic vegetation in and along the rivers would, for example, yield a rich harvest. A most notable discovery on the expedition to Tanganyika was a species of *Pteronia* (*P. Smutsii* Hutch.) in Northern Rhodesia, representing an extension northwards of more than a thousand miles in the known range of the genus.

Botanists will be specially grateful for the information so conveniently summarized in the first three chapters of Part V. The bibliography of South African botanical literature (with particular reference to the taxonomy of flowering plants) and the condensed history of botanical exploration in South Africa will be valuable sources of information for all who may be concerned with the flora of the country. Chapter 32 will immediately command the attention of all taxonomic botanists as it contains a new phylogenetic arrangement in which Dr. Hutchinson makes some very important modifications to the original sequence of the Dicotyledons as given in his "Families of Flowering Plants". From his further studies he has decided to "distribute the gamopetalous families among their nearest relations in the ARCHICHLAMYDEÆ". This step was foreshadowed in the author's earlier work, and most systematists will agree that the new proposals are a great improvement on the existing systems, which obscure the ancestry and true relations of the gamopetalous families. Dr. Hutchinson will probably meet most criticism in his emphatic reaffirmation that there are two main phyla in the Dicotyledons. To many, his two lines of development, one fundamentally and remaining predominantly woody, the other fundamentally and remaining predominantly herbaceous, will remain basically artificial though the author claims that by this means "parallelisms in floral structure which were formerly considered to be relationships may be more clearly recognized". The complete new scheme for the world families is promised in a future work, and until Dr. Hutchinson gives a detailed elaboration of his new proposals, criticism must be withheld. In the preliminary application of the new system to the South African families, it is noted that several families are regarded as diphyletic in origin, a view which many taxonomists will hesitate to accept.

Non-botanists may feel, with some justification, that the mass of botanical detail which occupies the bulk of the text is rather overpowering; it tends to swamp the descriptive (and occasionally somewhat forced) narrative. Furthermore, the reader will have difficulty in locating topics of special biological interest as the book has no index—a serious omission. Normally, one would expect new species and genera to be described in scientific journals rather than in a sequence of incidental footnotes in a book of this description. It would, at least, have been advisable to assemble the novelties in taxonomic order, for here again the lack of an index is a severe disadvantage.

It would be exceptional for a book of this detailed and descriptive character to be entirely free from errors, and a number of minor slips have been noted. These criticisms, however, do not detract from the high scientific value of "A Botanist in Southern Africa", and the author deserves a high measure of praise for his stimulating work. It remains to congratulate the publishers for their enterprise and confidence in producing this handsome volume in these days of utility and stringency. The book is lavishly illustrated and the photographs by Dr. Pole Evans, especially those in the six supplements, form a valuable register of the floristic features of southern Africa. A word of congratulation is also due to the author for his remarkably clear and helpful drawings

which, although without scale, will greatly assist in identification. Botanists, horticulturists and travellers will find much to appeal to them in this book, and it will be indispensable to all with interests in South African botany. GEORGE TAYLOR.

ETHNOS AND THE MODERN AGE

The Science of Man in the World Crisis

Edited by Ralph Linton. Pp. xv+532. (New York: Columbia University Press; London: Oxford University Press, 1945.) 23*s*. 6*d*. net.

TWENTY-ONE papers by twenty authors constitute a symposium inspired and edited by the professor of anthropology of Columbia University. The majority are of rather specialized anthropological interest, though there are some—notably "The Present State of World Resources", by H. A. Meyerhoff (professor of geology at Smith College)—which fit with difficulty into the pattern of the volume. The range of topics is intentionally wide in order to meet Prof. Linton's purpose. He points to the recent flood of books concerned with plans for world reorganisation, and supports the generally accepted view that the problems involved in the planning of civilization are so complex that they can be solved only by collaboration between workers in many different fields of scientific inquiry. Aware that more than a generation may elapse before the discoveries and techniques of one science become part of the regular working equipment of other sciences, he offers the present volume in an attempt to shorten the time interval.

It is perhaps inevitable that Prof. Linton should not only approach the study of world reorganisation from his particular professional point of view, but should also claim for anthropology a unique contribution to the solution of those problems of civilization which beset the citizen of the world. It is unfortunately true, however, that despite wide dissemination of knowledge of civilizations and cultures, the understanding between peoples which should result is greatly hindered by the normal organisation of science along national lines, in keeping with the rigid partition of the world between competitive sovereign Powers. Indeed, certain anthropologists—not all of German origin!—have been criticized for national or racial bias in the prosecution of their researches. Of the motives which actuate the Great Powers and frustrate the efforts of the peoples of the world to attain harmony in their complex relationships this volume says little: though they are not entirely ignored, as witness the final article on "Nationalism, Internationalism and War".

It is assumed in the discussion devoted to the physical and mental endowment of the races of mankind that the 'average reader' knows and accepts the basic facts of man's origin and evolution. The assumption seems to be unreliable, however, in view of widespread ignorance on the subject of man's antiquity, not to mention the controversies which have gathered around the topic of evolution. Prof. Linton does well frankly to admit the difficulty of handling within the outer frontiers of his subject both physical and cultural anthropology, of which the respective objectives, techniques and disciplines vary so widely from each other; but his emphasis is laid on the abundant opportunities for collaboration between them.

An omission—the more notable because the place of environment in the pattern of human life is mentioned—is the significance of climate as an influential factor in the shaping of society. Such a topic would have fitted well and easily into the design of this symposium. But such omissions as may be noted, though they affect the balance of the volume, do not affect the virtues of the individual essays, each an achievement of vigorous scholarship.

WALTER FITZGERALD.

INTRODUCTION TO PLATO

Discovering Plato

By Alexandre Koyré. Translated by Leonora Cohen Rosenfield. Pp. xi + 119. (New York: Columbia University Press; London: Oxford University Press, 1945.) 10*s*. net.

THIS is a delightful and much-needed book; may it be read as widely as it deserves. There is no doubt that Plato's dialogues are still, after twenty-four centuries, the best introduction to philosophy; but they themselves need to be introduced to the modern reader, who otherwise may come away with the wrong impression or none at all. Not only neophytes and the unlearned require help. Two recent books by writers of considerable academic standing are full of gross errors about Plato. One of the leading philosophers of the day has just published misunderstandings which an hour's reading of M. Koyré's book would have dispelled. Indeed one sentence would have gone a long way—"Though Socrates often has his fun at the expense of his interlocutors, Plato never mocks his readers". But Plato does expect his readers to play their part in the intellectual drama he unfolds. M. Koyré's concern is to prepare the modern reader to play it.

After an account of the intention and method of the dialogues, M. Koyré introduces us to the Meno, Protagoras, Theaetetus and the political part of the Republic. The introduction to the Republic is specially needed because Plato's politics are harder to understand than anything else he discussed. Even where his political views are most repulsive to modern ways of thinking, understanding ought to come before criticism. Too often Plato is represented simply as a hater of Athenian democracy and an admirer of the totalitarian Spartan regime. It is forgotten that Athenian democracy was in its intentions scarcely less totalitarian than the Spartan system. The main difference was that it was less thorough and efficient; it did allow for change and variety, but that was its weakness. Plato's totalitarianism was not his invention; it was just Greek politics. It is not noticed that Plato's severest criticism is directed against other forms of government and not democracy. The chief indictment of democracy is that its weakness tends to anarchy, which is the way to tyranny. It is forgotten that where Plato's positive proposals sound most oppressive, he was assuming that political power would be in the hands of genuine experts, who really knew what was right and what was wrong, that the others would all recognize the fact and therefore willingly obey them. M. Koyré reminds us of all these things, and many others.

The translator may be congratulated on a translation which does not read like one. There is a useful index and a foreword by Prof. Edman, whose encomium is not a bit overdone. A. D. RITCHIE.

Patients Have Families

By Prof. Henry B. Richardson. Pp. xx+408. (New York: Commonwealth Fund; London: Oxford University Press, 1945.) 16*s*. 6*d*. net.

THIS book is based on an investigation carried out by representatives of the medical profession and social services in New York into the relationship between stresses and strains in a family and the occurrence of disease. Members of the group were taken from the Faculties of Public Health, Medicine and Psychiatry of the Medical College at Cornell, the New York Hospital and its social service department and from the family case work service and the educational nursing department of the Community Service Society. They acted under the general direction of the author.

The aims of this 'family study' were, first, to study the interrelation between illness and the family situation and so try to counteract the present tendency of the medical profession to concentrate on disease alone, apart from the individual and his family; and secondly, to explore the best methods of co-operation between the different services in the treatment of difficult, unstable, family situations.

The importance of the above professions working together is shown, as are the methods by which close co-operation was achieved but, owing to the difference in the public health services in other countries, only the broad outlines of these methods would be of value outside the United States of America. On the other hand, the details given of fifteen families studied, analysed and treated should be of great interest everywhere in showing the different types of family situations met and their associated diseases, as well as the value of pooling the resources of the various services in obtaining a complete picture of the patient and his family. The book offers a stimulating impetus in the march towards a vigorous health policy. K. M. HAWKINS.

Tables of Elementary Functions

(In English and German.) By Fritz Emde. Pp. xii+181. (Ann Arbor, Mich.: J. W. Edwards, 1945.) (Copyright vested in the Alien Property Custodian, 1944: first published in Leipzig and Berlin, 1940.) 3.20 dollars.

THIS book is yet another example of a photolithoprint reproduction made in the United States by authority of the Alien Property Custodian. The original work, compiled by Emde at Stuttgart and published in 1940, is presented in conjunction with its English translation. Much of the information to be found in the 1933 Jahnke–Emde is included, with certain modifications; broadly speaking, those tables of elementary functions which were omitted from the 1938 edition and later found their way back into the American reprint.

Within its scope of 180 pages, there is a wealth of valuable material. First, a table of powers followed by factor-tables of numbers from 119 to 9997; secondly, a section dealing with tabular solution of quadratic, cubic and quartic equations; thirdly, a galaxy of tabulated results connected with the circular and hyperbolic functions (for both real and complex variables); and finally, a collection of tables and formulæ, dealing with special transcendental functions, such as e^{-x^2}, Planck's radiation function, Langevin's function and Chebyshev's polynomials.

It would be impossible and indeed unfair to attempt to give any sort of detailed description of its contents in a short review. It must suffice to say that the author has succeeded in producing yet another most valuable aid to mathematicians and computers alike. The book is well bound, clearly reproduced and would constitute a valuable addition to any scientific library. J. H. PEARCE.

Les derniers progrès de la chimie

Par Prof. Roger Simonet. Dix-septième édition. Pp. 244. (Paris: Éditions Balzac, 1944.) 75 francs.

THE present small book is written in an interesting style and covers a range of subjects not easily accessible outside patent specifications or large and expensive treatises. The first chapter deals with chemical synthesis, the second with catalysis (containing many interesting facts not usually met with), and the remaining pages deal with the structure of matter and radioactivity, the chemistry of hydrogen, the synthesis of ammonia and nitric acid, methanol, synthetic petrol, perfumes, dyes, drugs, rayon, plastics, artificial textiles, biochemistry, vitamins, hormones, 'poison gases', electrochemistry, and light alloys. The book contains, for its size, an astonishing amount of information, and gives an excellent survey of modern chemical industry. The paper is poor and in the copy reviewed some pages of text were blurred, but as a war publication it puts some other countries rather in the shade. At a time when so much rubbish is published, such a book deserves high praise, and the call for a seventeenth edition points to a demand for educational literature which is noteworthy.

Vegetable Matter in the New South Wales Wool Clip

By E. J. Milthorpe. Pp. vii+60. (Sydney: Central Wool Committee Testing House, 1943.) 21*s*.

THIS little book is excellently produced and illustrated. Its main purpose is to acquaint wool appraisers with the common fruits and other parts of plants which become caught up in the fleece of sheep in New South Wales, and it has a map to show from which parts of the State the common 'burrs' of wool come. It is surprising, considering the richness of the New South Wales flora, that so few species of plants contaminate wool; the book describes only forty-five species, and many of these are unimportant.

Apart from its use to the wool specialist, the book is interesting as a catalogue of a specialized form of plant dispersal; a form so efficient that some of the seeds from New South Wales germinate among the wool mills of the English Midlands.

E. ASHBY.

The Groundwork of Volumetric Analysis

By A. J. Mee. (Dent's Modern Science Series.) Pp. viii+72. (London: J. M. Dent and Sons, Ltd., 1945.) 2*s*. 6*d*.

MR. MEE'S book provides a course in practical volumetric analysis suitable for examinations of school certificate stage, covering acid-alkali, permanganate, and silver nitrate titrations. The experimental details and the methods of calculation are very fully and clearly described, and typical examples are worked out. The book is an excellent introduction to the subject and can be recommended as fulfilling its purpose, which is to help the beginner to understand the practice and theory of volumetric analysis. Many examples for exercise, with answers, add to the usefulness of the book.

SPECTROSCOPIC STUDY OF THE PERMEABILITY AND LYSIS OF RED BLOOD CORPUSCLES

By Prof. D. KEILIN, F.R.S.
AND
Dr. E. F. HARTREE
Molteno Institute, University of Cambridge

KNOWLEDGE of the reaction mechanism of different substances with intracellular enzymes or catalytic systems involved in the metabolism, growth and multiplication of cells is of fundamental importance in the study of the pharmacological action of drugs and of chemotherapy. Cells are, however, not equally permeable to substances which may react with intracellular catalysts, whether as metabolites, activators or inhibitors. As the rates at which such reactions may take place are often controlled by the permeability of cells to these substances, the study of the mechanism of cell permeability becomes of considerable theoretical and practical importance.

Advantages of Erythrocytes for the Study of Cell Permeability

It is now generally accepted that red blood corpuscles of vertebrates, and especially of mammals, form the most convenient material for the study of cell permeability, cell resistance and lysis. The great advantages offered by this material can be summarized as follows:

1. Blood is the most easily accessible material for experimental investigation and in small-scale experiments it can be provided by the worker himself.

2. Red blood corpuscles even in the smallest volume of blood form an immense population of cells which are more uniform in size and properties than cells of any other tissue in the organism.

3. Being completely free, these cells have the whole of their surface exposed to the same environment. In vertebrates they share this property only with leucocytes and spermatozoa which are, however, less readily available.

4. Since the red blood corpuscles are resistant enough to withstand washing in the centrifuge and resuspending in various fluids, a large population of cells can be uniformly exposed to the same conditions.

5. The presence within the corpuscles of a high concentration of haemoglobin is very helpful in the study of the permeability of these cells to substances which give rise to changes in the appearance or properties of the pigment. Studies on cell fragility are also simplified, as the degree of haemolysis can be measured by the amount of pigment liberated into the surrounding medium.

6. The complete haemolysis, which is often timed in the study of cell permeability, is easily recognized since the suspension of intact corpuscles is opaque, owing to scattering of light, whereas on lysis it forms a transparent solution of pigment.

The extensive literature on the permeability and lysis of red blood corpuscles, which has been well summarized in excellent reviews and books by Jacobs[1,2], Ponder[3] and Davson and Danielli[4], reveals a variety of methods devised for the study of these problems.

Haemoglobin as Indicator of Permeability and Lysis of Erythrocytes

In this article we are putting forward a new method for the study of the permeability and lysis of erythrocytes, a method based upon the remarkable spectroscopic properties of haemoglobin and its derivatives.

For this work we have used horse erythrocytes from fresh defibrinated blood. The cells were washed three times in isotonic saline or Ringer solutions and finally suspended in the test solution which was generally isotonic phosphate buffer of an appropriate *p*H within the range 6·0–7·3. In addition to this material we have used methaemoglobin corpuscles, that is, corpuscles in which oxyhaemoglobin has been oxidized to methaemoglobin without damage to the cell wall. For this purpose erythrocytes are washed three times with saline as above and mixed with an equal volume of an isotonic solution of sodium nitrite (1·06 per cent). After one minute the suspension, which turns chocolate brown, is washed three times in the centrifuge with ten volumes of 0·9 per cent sodium chloride. The cells now form a very dark brown suspension and show the characteristic absorption spectrum of acid methaemoglobin. The catalase and carbonic anhydrase in these cells show their normal activity whereas glutathione is oxidized to the —SS— form. The methaemoglobin corpuscles are stable for twelve hours in the cold, after which a gradual lysis takes place.

It must be remembered that haemoglobin and oxyhaemoglobin are ferrous compounds, whereas methaemoglobin is a ferric compound. In presence of oxygen the two ferrous compounds are in equilibrium oxyhaemoglobin $\rightleftharpoons$ oxygen + haemoglobin, but the addition of an oxidizing agent such as $K_3Fe(CN)_6$ brings about the oxidation of haemoglobin to methaemoglobin which causes a shift of equilibrium and in consequence a complete oxidation of oxyhaemoglobin. Since methaemoglobin possesses no affinity for oxygen a quantitative evolution of oxygen is obtained; in other words, oxyhaemoglobin on oxidation becomes completely deoxygenated.

It has already been shown that methaemoglobin can act as an indicator changing its colour and absorption spectrum with change of *p*H between 6·8 and 9·5 [5,6]. This change can also be observed within methaemoglobin corpuscles[7], and advantage was taken of this property by Keilin and Mann[8] to determine the activity of carbonic anhydrase within intact corpuscles. For this purpose the velocities of the spectroscopic change from acid to alkaline methaemoglobin, on treating the suspension of corpuscles with bicarbonate or alkaline phosphate solution, were determined in presence and in absence of sulphanilamide which, as was previously shown[9], is a specific inhibitor of carbonic anhydrase. In the same way it was possible to establish spectroscopically the intimate relationship between the activity of carbonic anhydrase and the chloride shift[8].

Spectroscopic Demonstration of the Permeability of Erythrocytes to Certain Substances

The rapid reactions of haemoglobin and methaemoglobin with a number of substances, resulting in the formation of spectroscopically well-defined and easily recognizable compounds, enable us to determine the permeability of erythrocytes to such substances. Thus the changes in colour and absorption spectrum of oxyhaemoglobin corpuscles and methaemoglobin corpuscles show that the cells are permeable: (*a*) to

oxygen, carbon monoxide, nitric oxide and nitrosophenol which combine with hæmoglobin; (*b*) to nitrites, quinones and hydroxylamine which oxidize hæmoglobin to methæmoglobin; (*c*) to hydrazine, sodium diethyldithiocarbamate, *p*-phenylenediamine, catechol and a number of other phenols, which reduce methæmoglobin to hæmoglobin; (*d*) to cyanide, sulphide, azide, glyoxaline and peroxides which combine with methæmoglobin; (*e*) to such anions as carbonate, phosphate and borate which, by changing the intracorpuscular hydrogen ion concentration, shift the equilibrium between acid and alkaline methæmoglobin with consequent changes in colour and absorption spectrum; and finally (*f*) to sulphanilamide (the specific inhibitor of carbonic anhydrase) and chloride or bromide ions which affect the velocity of the above equilibrium reactions. These reactions can all be followed readily by changes in the colour of the intracellular pigment or by the changes in the absorption spectra which can be seen with a small dispersion spectroscope. The most convenient instrument of this type is a microspectroscope ocular attached to a microscope, although a hand spectroscope (direct vision) is perfectly satisfactory for such observations. It is of interest at this point to refer to the striking changes in the permeability of methæmoglobin corpuscles brought about by washing them in isotonic solutions of phosphate of $p\mathrm{H} < 6{\cdot}3$. Keilin and Mann[8] showed that these corpuscles are impermeable to anions such as carbonate and that in consequence they can be incubated for several hours with an isotonic mixture of sodium chloride and sodium carbonate without affecting the colour and spectrum of methæmoglobin which remains in the brown acid form ($p\mathrm{H} > 6{\cdot}8$). If, however, the cell suspension is plasmolysed by addition of a little saponin a red solution with the characteristic absorption spectrum of alkaline methæmoglobin is rapidly obtained. Similar results are observed using erythrocytes washed with other buffers of *p*H 6 such as phthalate/sodium hydroxide, or citrate/sodium hydroxide mixtures.

Since the brown acid methæmoglobin reacts almost instantaneously with azide (NaN_3), forming a red azide methæmoglobin compound, the modified methæmoglobin corpuscles which are impermeable to carbonate ions may be used for the study of penetration of azide into the corpuscles from surrounding media of varying hydrogen ion concentrations. For this purpose 20 c.c. of methæmoglobin corpuscles were washed with 200 c.c. *M*/6 potassium dihydrogen phosphate and then with two lots of 200 c.c. 0·9 per cent sodium chloride. The corpuscles were then suspended in twenty-five volumes of isotonic buffer solution of *p*H ranging from 6 to 9, and 1·5 c.c. of each of these suspensions was treated with 0·3 c.c. *M*/250 sodium azide, which was found to be just sufficient to transform the total acid methæmoglobin into azide methæmoglobin. The observations were carried out with the microspectroscope and double-wedge trough (Fig. 2, *A* and *B*) which will presently be described; the compartments e_1 and e_2 of the trough receiving methæmoglobin and azide methæmoglobin corpuscles respectively. The times for the complete change in colour and absorption spectrum at various *p*H are given in Table 1, whereas the rate of penetration of azide at *p*H 7·3 is shown in Fig. 1.

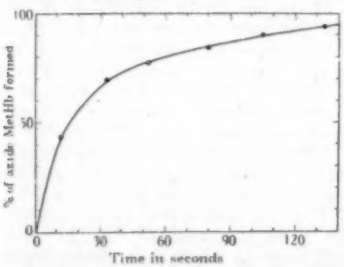

Fig. 1. Diffusion of azide into methæmoglobin corpuscles. 2 c.c. 'impermeable' corpuscles in isotonic phosphate *p*H 7·3 treated with 0·3 c.c. *M*/250 sodium azide at 18° C. With lysed corpuscles the reaction is instantaneous.

Table 1.

*p*H	6·0	6·5	6·8	7·3	7·8	9·0
Time for complete reaction (min.)	<0·03	0·38	0·67	2·0	18·5	>30

On the other hand, the time of penetration of 0·3 c.c. *M*/500 cyanide into 1·5 c.c. of these corpuscles as shown by transformation of acid methæmoglobin into the cyan methæmoglobin compound at *p*H 6·0 and 7·7 was about 10 seconds in each case, which was equal to the time of reaction of the acid methæmoglobin in solution with the same concentration of cyanide. This clearly shows that whereas from an acid medium azide penetrates rapidly into these corpuscles, when the medium is more alkaline the penetration of azide is much slower; hence the *p*H of the surrounding medium appears to be the limiting factor in the rate of the reaction between the intracellular acid methæmoglobin and azide.

The study of these modified methæmoglobin corpuscles offers a plausible explanation of the peculiar behaviour of sodium azide as an inhibitor of cellular respiration. It was shown previously[10] that whereas 10^{-3} *M* sodium azide inhibits almost completely the activity of the free cytochrome system within the *p*H range 6·0–7·5, the respiration of intact yeast cells is inhibited by 90–100 per cent at *p*H 5·6–6·2, by 75 per cent at *p*H 6·7, by only 5–17 per cent at *p*H 7·3, and not at all at *p*H 7·5. It is therefore possible that at alkaline *p*H azide does not reach the intracellular cytochrome oxidase to form an inactive complex.

Impermeability of Erythrocytes to Hyposulphite and Ferricyanide

It is well known that the addition of sodium hyposulphite to a suspension of oxyhæmoglobin corpuscles causes a rapid deoxygenation in the same way as removal of oxygen by evacuation. The colour of the suspension changes from bright red to purple while the two sharp absorption bands of oxyhæmoglobin are replaced by the one broad diffuse band of hæmoglobin. This reaction, however, gives no indication that hyposulphite penetrates the corpuscles since removal of dissolved oxygen from the surrounding medium must bring about the dissociation of intracellular oxyhæmoglobin in the same way as does the lowering of oxygen tension either artificially by evacuation or under normal biological conditions. That hyposulphite does not penetrate the corpuscles can readily be demonstrated with a fresh dilute suspension of methæmoglobin corpuscles. Treatment of such a suspension with sodium hyposulphite causes no change in colour or absorption spectrum, but if saponin is now added the cells are lysed and the brown acid methæmoglobin is immediately converted to a purple solution of hæmoglobin. In this experi-

ment sodium hyposulphite can be replaced by Stokes' reagent (alkaline ferrous tartrate) since ferrous ions, like other cations, do not penetrate the corpuscles.

In the same way it can be shown that red blood corpuscles are impermeable to ferricyanide ions. Thus, the addition of a small quantity of potassium ferricyanide to oxyhæmoglobin corpuscles does not affect the pigment, but after lysis with saponin the liberated oxyhæmoglobin is immediately oxidized to brown acid methæmoglobin, while at the same time the absorption spectrum undergoes a fundamental change. The fact that the colour of oxyhæmoglobin corpuscles treated with a strong solution of ferricyanide remains unchanged even after twenty-four hours was demonstrated so early as 1883 by von Mering[11] and was erroneously used by Hoppe-Seyler[12] in support of his view that hæmoglobin within corpuscles and in solution are not identical.

In these experiments potassium ferricyanide may be replaced by cupric chloride, since the corpuscles are not permeable to cupric ions, which rapidly oxidize a solution of oxyhæmoglobin to methæmoglobin. On the other hand, the non-dissociable copper acetylacetate, which slowly oxidizes oxyhæmoglobin, penetrates the corpuscles.

The main results of these experiments summarized in Table 2 provide striking class demonstrations inasmuch as the colour changes (brown to purple or red to brown) can be seen at a considerable distance when suitable vessels and erythrocyte concentrations are chosen.

TABLE 2.

Corpuscles containing	$Na_2S_2O_4$	$Na_2S_2O_4$ + saponin	$K_3Fe(CN)_6$	$K_3Fe(CN)_6$ + saponin
HbO_2	Hb	Hb	HbO_2	MetHb
MetHb	MetHb	Hb		

Lysis of Red Blood Corpuscles Observed Spectroscopically

It is generally recognized that there are still a number of technical difficulties to be overcome in the quantitative study of hæmolysis by various lytic agents or systems. Even the recognition of the end point of the reaction, that is, when hæmolysis is complete, requires much practice though the experimental procedure is a simple one. More elaborate methods and instruments have hitherto been necessary in experiments aimed at the quantitative study of rates of hæmolysis at successive stages of the reaction[3].

The fact that erythrocytes are impermeable to ferricyanide which, however, reacts immediately with oxyhæmoglobin liberated by lysis can be utilized for the spectroscopic study of the kinetics of hæmolysis brought about by various agents under different conditions. The principle of the spectroscopic method consists in matching at suitable intervals of time the absorption spectrum of a suspension of erythrocytes treated with potassium ferricyanide and a lytic substance, with that of the same depth and concentration of suspension in a double-wedge trough. One compartment of the latter contains the unmodified suspension of corpuscles whereas the other contains the suspension plus potassium ferricyanide and excess of saponin which gives a clear solution of acid methæmoglobin. The apparatus used for this purpose, shown diagrammatically in Fig. 2, was originally devised[13] for the study of methæmoglobin and has since found wide application in the quantitative study of hæmatin pigments generally and of intracellular

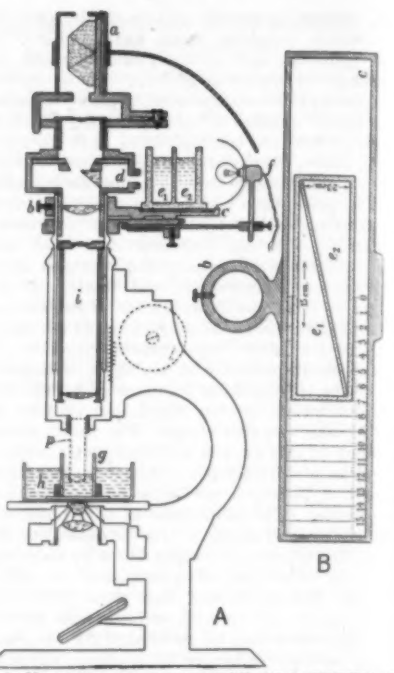

Fig. 2. MICROSPECTROSCOPE OUTFIT (*A*) AND DOUBLE-WEDGE TROUGH (*B*).

carbonic anhydrase. A stock suspension of erythrocytes is prepared by diluting the washed cells 150 times with isotonic phosphate buffer of suitable *p*H (for example, 6·5). 5 c.c. of this suspension is placed in a flat-bottom cylindrical tube *g* which has an internal diameter of 16·6 mm., thus giving a layer 2·3 cm. deep. The temperature of the suspension can be controlled by means of the water bath *h* standing on the microscope stage just above the condenser. The same suspension is put in both compartments e_1 and e_2 of a glass double-wedge trough which is 15 cm. long and has an optical depth of 2·3 cm. The suspension in e_2 is treated with a few mgm. saponin and two drops of saturated potassium ferricyanide solution giving a clear brown solution of acid methæmoglobin. The tube holder and mirror, which are supplied attached to the microspectroscope *a* in front of the aperture *d*, are unscrewed and removed in order that the trough may be placed close to *d* on the brass platform *c* which is attached to the microscope by means of the ring *b*. The exact position of the trough in relation to the aperture *d* is read on the scale fixed to the brass platform and covered by a sheet of glass upon which the trough slides easily. The tube *g* is illuminated by means of a suitable compact filament lamp focused upon the substage mirror, whereas the trough is illuminated by means of an 8-volt flash lamp bulb (*f*) with a compact filament. The intensities of the two lamps can be regulated by means of independent rheostats. Experiments were carried out with tube *g* at 37°, 20° and 2·5° C.; ice and water being placed in *h* to reach the third temperature. At 37° the rates of hæmolysis were so high that thermostatic control was unnecessary.

The experiments begin by addition to the suspension in *g* of 0·2 c.c. 1 per cent potassium ferricyanide in

isotonic salt solution. By means of the microspectroscope ocular the spectra of the suspension g and of the liquid in the trough are matched. The bright backgrounds to the absorption bands are matched by adjusting the rheostats. At this stage the trough reading (position of the left-hand edge) is zero corresponding to 0 per cent lysis. When the suspension in g has attained the correct temperature a standard solution of lytic substance in isotonic saline is run in from a pipette and followed by a few bubbles of air to ensure adequate mixing. A stop-watch is started simultaneously. The cells undergo a gradual lysis with liberation of oxyhæmoglobin which is instantaneously oxidized to acid methæmoglobin. While keeping the illumination of the two spectra equal by means of the rheostats the trough is moved along the platform towards the left and its position at which the two spectra match in their entirety is read off from the scale at convenient time intervals according to the rapidity of lysis. The final position of the trough will be 15 cm., corresponding to 100 per cent lysis. The percentage lysis at any instant can therefore be obtained by multiplying the trough reading by 100/15. If the reaction is very slow the corpuscles will tend to sediment and it will be necessary to stir the suspensions in g and e_1 from time to time. As the width of the double-wedge trough is fixed the concentration of the corpuscle suspension placed in it must be selected so as to give clear and easily matched absorption bands, for mixtures of HbO_2 and MetHb in all proportions. The concentration of corpuscles in the experimental vessel g, however, can be varied according to requirements. The volume (x) in c.c. to be put into g can be calculated from the equation $x = \frac{\pi r^2 l n}{m}$, where l is the optical depth of the trough in cm., m and n are the concentrations of corpuscles in the vessel g and in the trough respectively and r is the radius of g in cm. The clarity of the absorption spectra is much improved by inserting a Ramsden ocular, after removing its attachment ring (i, Fig. 2), into the microscope tube.

The instrument as represented in Fig. 2 is extensively used in our laboratory for a great variety of purposes such as estimation of hæmatin in hæmoglobin, catalase and peroxidase, determination of hæmatin and cytochrome in yeast, bacteria, plant and animal tissues and in extracts of such materials. It can be slightly improved by inserting an optical glass plunger in place of the microscope objective, which is normally removed when using the microspectroscope except for examination of very small areas. A vernier attachment to the coarse adjustment of the microscope would then permit a more accurate measure of the optical depth in g than is obtained by calculation, which takes no account of the meniscus error.

In preliminary experiments we found that the addition of small amounts of ferricyanide had very little effect on the velocity of lysis by saponin. The time for the complete lysis was increased by about 5 per cent, which did not interfere with the comparative studies of lysis.

We have investigated by the above method the lytic properties of saponin, sodium desoxycholate and sodium dodecylsulphate. Since, however, a detailed study of the kinetics of these reactions lies beyond the scope of this paper we are giving only a few examples of our results (Figs. 3 and 4). The characteristic S-shaped curves obtained in these experiments, especially with saponin, have already been discussed by Ponder[3].

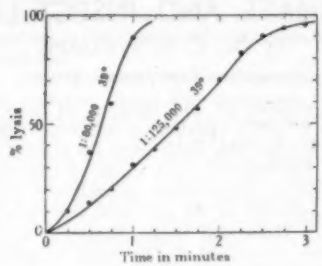

Fig. 3.

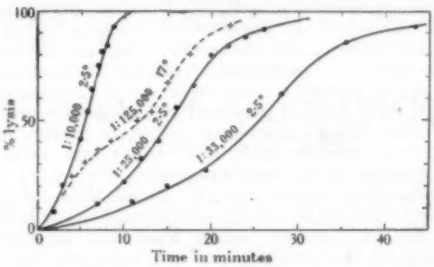

Fig. 4.

Figs. 3 and 4. LYSIS BY SAPONIN AT VARIOUS DILUTIONS AND TEMPERATURES OF 5 C.C. DILUTE SUSPENSION OF ERYTHROCYTES IN ISOTONIC PHOSPHATE BUFFER pH 6·5.

The spectroscopic method for the study of cell permeability and hæmolysis has great advantages over other methods. Since hæmoglobin and its derivatives (oxyhæmoglobin and methæmoglobin) can react with a great variety of substances, forming well-defined and spectroscopically easily recognizable compounds, the penetration of these substances within corpuscles can be followed by changes in colour and absorption spectra of the pigment which in the oxidized state (methæmoglobin) can act even as an intracellular pH indicator. On the other hand, a substance like ferricyanide to which corpuscles are completely impermeable is exceptionally suitable for the quantitative study of hæmolysis as it reacts instantaneously with oxyhæmoglobin liberated from corpuscles, changing both the colour and the absorption spectrum. The matching of absorption bands with a small dispersion spectroscope is a very easy and precise manipulation not requiring elaborate instruments and not affected by slight differences in colour or turbidity of solutions or suspensions.

The spectroscopic method can therefore be used not only for determining the time of complete hæmolysis but also for following the kinetics of the whole course of the reaction, which is essential for a proper study of the mechanism of cell permeability and lysis.

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CLIMATE AND INSECT LIFE

By Dr. C. B. WILLIAMS
Rothamsted Experimental Station

THE problem of the relation of insect life to climate and weather conditions has always attracted naturalists, both from its scientific and its practical importance; but most of the early work was qualitative rather than quantitative and, owing to the complexity of the problem, little real progress was made. Here and there, however, some of the results were expressed in the form of general laws, such as the 'hyperbola' relation between temperatures and length of development, and Hopkins' 'bio-climatic laws' relating to the dates of occurrence of biological events, including the outbreaks of certain insects.

In 1929, the Conference of Empire Meteorologists in London pressed for the extension of such studies; and in 1931 Uvarov produced an excellent survey of the literature to that date—which is (partly as a tribute to its own value) now out of date owing to the progress of the last fifteen years.

At a joint meeting of the Royal Meteorological Society and the Royal Entomological Society held in London on June 20, papers were read on various aspects of the problem, and emphasis was laid on the urgent need for more work and more co-operation between entomologists and meteorologists if rapid progress is to be made.

The effect of climate and weather conditions on insects is of course only one particular part of the wider study of bio-climatics, but it is worthy of separate consideration in view of the enormous number of species of insects, the possibilities that they have for very rapid changes in numbers, and their great economic importance as pests and as carriers of disease.

There are certainly more than one million different species of insects in the world—more than all other kinds of animals and plants together—and each is subject to the effect of weather and climate from the moment that the egg is laid, through the various stages of metamorphosis, to maturity and death. Each is affected in speed of development, in fertility, and in length of life; and, as these three factors combined determine the rate of multiplication, climate and weather conditions are the major part of the study of insect populations and hence of insect outbreaks or epidemiology.

The permanent existence of an insect in any area depends in general on the 'climate', or average weather conditions of that area. Its variations in numbers in any locality are due to the variations in climatic conditions from day to day or from year to year that we call 'weather'. Even the movement of insects, passive or active, short flights, or long-distance migrations, are at all times at the mercy of weather conditions: and when any particular insect is not affected directly, it may easily be affected indirectly through the effect on its natural enemies or its food supply.

Turning to the meteorological factors involved, we find conditions of equal variety and complexity. What we call 'weather' is the summation of change in a number of separate factors: temperature, humidity, pressure, light, etc. Under temperature we have to consider the average air-, water- or soil-temperatures; also its daily and seasonal variation, average maximum, average minimum, and also extreme maximum and minimum. An occasional frost, once only in several years, may have an enormous effect on the insect population; and tropical conditions are determined almost as much by the absence of low temperatures as by the presence of a high average. The question of radiant heat is also involved. Water can take the form of rainfall (the seasonal distribution of which is at least of as great importance as the total amount), air humidity, cloud (affecting radiation from the sun during the day and from the earth at night), dew, soil moisture and so on. Wind and air movements affect evaporation from both plants and insects. Barometric pressure, and the number of hours of daylight or sunshine also have complex direct and indirect results.

To add to the complexity, insects, as opposed to plants, have powers of movement which enable them, within perhaps only a few feet, to exert a choice among a variety of microclimates and so to avoid dangerous extremes. In fact, we have the two great

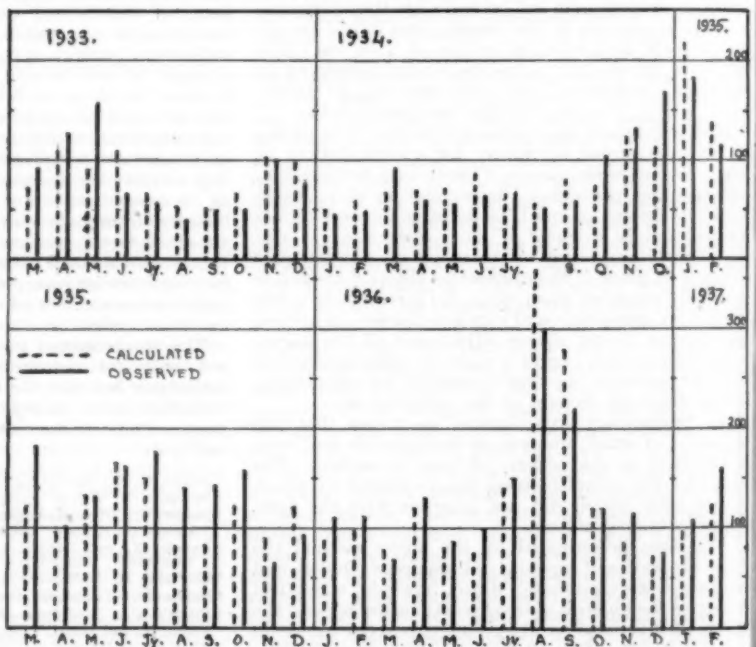

DIAGRAM SHOWING THE RELATION BETWEEN THE OBSERVED ABUNDANCE OF INSECTS IN A LIGHT TRAP AT ROTHAMSTED, AND THE VALUE CALCULATED BY A MULTIPLE REGRESSION BASED ON THE TEMPERATURE AND RAINFALL FOR THE THREE PREVIOUS MONTHS. AVERAGE ABUNDANCE FOR EACH MONTH = 100.

complexes of insect variety on one hand and climatic variety on the other; and the task of analysis and synthesis of their inter-relations is almost Herculean.

Until recently, meteorologists had the advantage in that most of their factors could be easily expressed numerically as measurements and so lent themselves to mathematical treatment. It is one of the main tasks of the entomologist in the near future to convert as many as possible of his observations into measurements. The day has come when expressions of the type "not quite so common" or "rather more abundant" must be replaced by terms comparable in accuracy to the meteorological records with which we wish to correlate them. But the task is by no means easy, and many experiments and many mistakes will have to be made before anything like success can be achieved.

It is interesting to speculate as to whether there is more hope of progress by analysing and simplifying the problem into its component parts in controlled laboratory experiments; or by tackling the whole complex of observations in the field! In this connexion it may be noted that the whole tendency of field experiments in agriculture in the last twenty-four years has been away from extreme simplification, and towards greater complexity. It has been found that, if sufficient facts are available, the complex data can be analysed by statistical methods, and more information can be obtained in a shorter period, particularly on the problem of inter-relations of one factor with another, which are eliminated by extreme simplification.

Undoubtedly more progress has been made in the past by studies under laboratory conditions, but the application of the laws and principles so discovered back again to problems in the field has been disappointing.

My own feeling is that—whatever the difficulties—we must study the insects so far as possible in the field under natural conditions; and experiments and field observations were started at Rothamsted about ten years ago with this in view. A standardized light trap was put out into one position in a field and was used to catch insects for more than 1,400 consecutive nights in four years. The number of insects captured each night was used as a basis for correlation with meteorological factors. The field observations were unfortunately brought to an end by the War, but from the thousands of figures already obtained we have been able to get measurements of the effect of most of the principal meteorological factors both singly and in combination with others. Finally, we have been able to forecast the general level of insect abundance from the weather conditions of the previous months. As an example of this, the accompanying diagram shows the correspondence between observed and calculated abundance of insects at Rothamsted for forty-eight consecutive months; the calculated figures being based on two multiple regression formulæ, one for the winter months, and one for the summer. The mathematical analysis showed that, under the climatic conditions of the area, rainfall is the determining factor of insect abundance in the summer, and temperature in the winter; a result which is obviously sound in a district where the rainfall is more or less constant throughout the year while the temperature varies from low in winter to high in summer.

But, of course, the problem must be attacked from all sides and progress will be made from all directions, if only accuracy of measurement can be brought into the biological side. The problem is essentially a mathematical one, and the accuracy of the results will depend on the absence of vagueness in the original observations.

The joint meeting of the Royal Meteorological Society and the Royal Entomological Society, after hearing short papers by Major H. C. Gunton, Dr. C. B. Williams, Dr. A. E. Slater and Dr. B. P. Uvarov, and an interesting general discussion, passed resolutions emphasizing the need for more bio-climatic work on insects and the need for further training of economic entomologists in the principles of meteorology. It was also suggested that other biological societies should take some share in responsibility for the production of the annual Phenological Report, at present sponsored entirely by the Royal Meteorological Society.

WEATHER AND ELECTRIC POWER SYSTEMS

A JOINT meeting of the Institution of Electrical Engineers and the Royal Meteorological Society was held on October 18 to discuss the effects of weather on electric power supply systems.

The meeting was opened by four short papers, two by Mr. J. S. Forrest and Mr. H. W. Grimmitt presenting the subject from the point of view of the electrical engineer, and two by Mr. A. J. Drummond and Wing-Commander R. M. Poulter describing the meteorological point of view. In the ensuing general discussion, the following speakers took part: Mr. C. K. M. Douglas, Mr. R. A. S. Thwaites, Dr. J. Glasspoole, Mr. E. B. Powell, Mr. E. G. Dymond, Mr. G. Manley, Mr. C. G. Carrothers, Mr. J. F. Shipley, Mr. E. E. Hutchings, Mr. W. Hill, Mr. C. T. Melling, Mr. W. N. C. Clinch, Mr. P. Schiller, and Mr. G. W. N. Cobbold.

In the course of the meeting, a demonstration was given of the *radio-sonde*, and other meteorological instruments operating on electrical principles. The main features of the discussion are summarized here.

In general, weather affects power systems in two ways: it causes variations in the load on the plant, and it may, under abnormal conditions, cause actual damage to equipment and an interruption of supply.

Load Variations Due to Weather

The lighting load is mainly a function of the daylight illumination, while the heating load is determined largely by the air temperature, and, to a lesser extent, by the wind velocity and relative humidity. The heating load requires serious consideration as it may amount to a significant proportion of the total load. For example, in the case of the south-east England electricity supply system, the peak load on two winter days, only a week apart, was found to differ by 22 per cent, which was 400,000 kW., owing to a drop of 25° F. in the mean air temperature.

Many supply engineers have derived empirical relationships between load and temperature, and between load and daylight illumination. In this way, they are able to predict, within a few per cent, the effect which changes in temperature or illumination will have on the load. In addition, three-dimensional models have been prepared in order to study the correlation between load, temperature, and illumination. There is, however, scope for further work on this subject.

Breakdowns Due to Abnormal Weather

Power system plant, particularly if installed outdoors, is liable to break down electrically, or to sustain mechanical damage under abnormally severe weather conditions. The insulation of overhead lines and substations may flash over owing to moist conducting films deposited on the surface by fog and atmospheric pollution. Thunderstorms frequently cause breakdown of insulation, and in the case of overhead lines, lightning is responsible for about 60 per cent of the total number of breakdowns. It is also the cause of a large proportion of transformer failures. In order to obtain data on thunderstorms, the Central Electricity Board has installed thunderstorm recorders in various parts of Great Britain. These instruments make a continuous record of atmospherics, and give an indication of the distance and the severity of the storm. The records obtained are correlated with the breakdowns due to lightning on the power system.

Ice storms of various types may cause extensive mechanical damage to overhead lines. Fortunately, such storms are not common, and during the last twenty years have occasioned only about ten major breakdowns in Britain. The most dangerous weather conditions are those which lead to a heavy deposit of ice on the overhead-line conductors. The ice may be in the form of frozen sleet, rime, or glazed frost. Such deposits are formed if the surface air and the conductor temperatures are just below freezing point, and liquid precipitation, which may be supercooled, falls from a relatively warm layer above the cold surface air. The most frequent type of damage is conductor breakage due, either to the conductors coming into contact with each other and being burnt through by the resulting short-circuit current, or to pure tensile failure under the weight of ice. Under very severe conditions, cross-arms may be broken, and steel towers buckled. The worst ice storms in Britain in recent years occurred in 1933, when sleet caused extensive damage in South Wales and other districts, and in 1940 when conditions giving rise to a belt of glazed frost about forty miles wide persisted for several days. In both cases, heavy ice deposits up to 5 in. diameter accumulated on overhead-line conductors. In 1937, damage was caused locally in North Wales and in the Pennine area owing to the combined effects of ice deposit and high wind.

The Electricity Commissioners' regulations specify certain minimum requirements for the construction of overhead lines, but the supply engineer may, if he considers it necessary, construct lines with a higher factor of safety, and it is on this question that guidance from meteorologists is useful. It would also be of assistance to the overhead-line engineer if the meteorologist could indicate which parts of a country are likely to be immune from ice storms.

Weather Statistics

Data on past weather are required for correlation with load variations and plant breakdowns, and as a basis for the design of new equipment, particularly for outdoor operation. The electrical engineer has therefore frequently to make use of the meteorologist's data on air and soil temperatures, solar radiation, wind velocities, thunderstorms, frost, fog, relative humidity and atmospheric pollution. Precipitation data are of primary importance to the hydro-electric engineer. It is considered that weather statistics should be objective. Thus, daylight illumination expressed in foot-candles is more likely to be useful than subjective estimates of visibility and cloudiness, and there would seem to be some scope for the development of a standard method of measuring daylight illumination.

Weather data can be obtained from the *Daily Weather Report*, the *Monthly Weather Report*, and the various standard books of averages issued by the Meteorological Office. Rainfall maps to a scale of 2 miles to 1 inch have recently been prepared for the North of Scotland Hydro-Electric Board, and maps of this scale are now available for the whole of Britain. Progress has been made in obtaining data on the frequency of occurrence of heavy falls of rain, and observations taken at Kew Observatory have shown that the standard rate of precipitation adopted for wet tests on insulators, 3 mm. per minute, is only likely to occur once in ten years. Work is also being carried out on evaporation and run-off, and on wind data required for wind-power plant. The Meteorological Office is now engaged in the preparation of a climatological atlas of the British Isles which will give not only the means, but also the extremes and frequencies of occurrence of the main meteorological elements.

There is an increasing tendency to utilize electrical methods in deriving statistics of thunderstorms. Thus, point discharge observations and records of radio atmospherics can be used as a measure of the severity and frequency of occurrence of thunderstorms. Electrical devices can be used to count the lightning flashes within a given distance.

Weather Forecasting

Weather forecasts are required by power system operators in order to assist in preparing loading and maintenance programmes, and in taking precautions against damage due to abnormally severe weather. Such precautions include the circulation of heavy currents through transmission lines in order to prevent the formation of ice deposits, and the provision of alternative routes of supply when thunderstorms are imminent. It is essential that the forecasts should have a high degree of accuracy, and if the weather situation changes after the forecast has been issued, the original forecast should be cancelled immediately. Forecasts of ice storms, thunderstorms, and sudden falls in temperature are the most important.

The forecasting of ice storms which are liable to endanger overhead lines presents a difficult problem. The conditions which give rise to these storms are exceptional, and the formation of adherent ice deposits depends on the temperatures of the conductors, the surface air, and the upper air being within certain rather narrow limits ; a very accurate forecast of surface and upper air temperatures, and also of wind velocity, would be required.

The technique of thunderstorm forecasting is relatively well-developed. Two methods are employed, the first being the radio method, which is based on the fact that atmospherics are produced by lightning flashes. The reception of atmospherics thus gives definite evidence of the existence of a thunderstorm, and the approximate location of the storm can be determined from the amplitudes or from the bearings of the atmospherics received at different sites. The development of the storm can be followed, and some hours warning can be given of the probable outbreak of the storm in a certain district. The second and more usual line of attack consists in taking upper-air soundings to determine the stability or instability of the atmosphere. Observations of the pressure, temperature, and humidity up to heights of 70,000 ft.

are obtained from *radio-sonde* ascents, and are immediately plotted on a temperature-entropy diagram (tephigram). By comparing the observed results with the saturated adiabatics and dew-point lines on the tephigram, it is possible to forecast the vertical cloud development, and to estimate the probability of conditions occurring which will give rise to thunderstorms. It is of interest to note that the *radio-sonde* transmitter at present used for this work in Britain weighs just over 3 lb., and has a range of more than 150 miles; the radiated power is about 40 mW. at a frequency of 27 Mc./s.

In the case of sudden falls in temperature, a reasonably accurate forecast can be given, but only for a day or so ahead. Long-range or seasonal forecasting is not yet possible in Great Britain, but during the war years considerable advances have been made in the accuracy of short-period forecasts and warnings. There seems to be a need in the electricity supply industry for an accurate and specific 6-hour or 12-hour forecast, and it is considered that there is room for closer collaboration between the meteorological services and the power system control centres. It may not be possible for these services to issue forecasts which are sufficiently local to fulfil all the requirements of the supply engineer, and it is suggested that the most efficient scheme would be for the supply authority to employ a meteorologist who had a knowledge both of the local weather features, and of the special characteristics of the electricity system. Such a meteorologist could obtain hourly weather reports from the teleprinter network of the Meteorological Office, and could utilize these in the preparation of his own local forecast.

Closer co-operation between meteorologists and electrical engineers should be mutually beneficial; for the engineers may supplement the meteorologists' data, and may also assist in the development of the highly specialized electrical and radio methods which are now being employed in meteorology.

J. S. FORREST.

DEVELOPMENT OF A CHEMOTHERAPY FOR SYSTEMIC ARSENICAL POISONING

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AND
L. N. OWEN and G. SHAW
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STUDIES by G. R. Cameron and his colleagues had shown by 1942 that in systemic lewisite poisoning a condition prevails in the first few days which in some particulars resembles traumatic shock, being marked by hæmo concentration. It was found that administration of plasma, or of other fluids, was of no avail in reducing the mortality caused by a given dose of lewisite. It was therefore decided that the first step in the treatment of lewisite poisoning must be the inactivation of at least that part of the arsenical causing shock.

The first aim, therefore, was to find the site of damage to the blood capillaries, that is, the site of abnormal loss of protein from the circulation. To facilitate this, a serum albumin was prepared which was tagged by allowing it to react with the diazonium hydroxide of a dye of the trypan blue type. This gave a blue serum albumin, movements of which in the body could readily be followed by the colour. The physical properties of this albumin (solubility, osmotic pressure, electrical charge, titration curve, specific viscosity, and molecular weight) were very little different from those of the original albumin. With its use we found that when lewisite is painted on to the skin of a rabbit, the subsequent hæmo-concentration is preceded by an increase in the rate of loss of albumin from the blood to about twice the normal value. There is a considerable loss of plasma in the region contaminated by lewisite, but this does not account for more than a small fraction of the increased rate of loss of albumin from the circulation. Most of the increased rate of loss occurred at sites widely distributed through the body, the loss in the skeletal muscles and viscera being particularly marked[1,2].

It was therefore concluded that a drug was required with the following properties: (1) It shall be able to reach the whole vascular system. (2) It shall be sufficiently non-toxic to eliminate the possibility of dangerous complications if an overdose is given. (3) It shall prevent arsenicals penetrating from the blood-stream into cells. (4) It shall remove arsenicals from cells into which they have penetrated. (5) The product of reaction between the drug and the arsenical shall be readily excreted.

It should be emphasized that these conclusions were based, as were the subsequent experiments, on consideration of complete physiological units, and not on, for example, consideration of enzyme systems. Voegtlin had shown that glutathione would protect cells against the action of arsenicals, and Peters, Stocken and Thompson[3] had in 1940 shown that 1 : 2 dithiols have a protective action against lewisite which is exerted through the affinity of the vicinal SH groups for arsenic. Dithioglycerol (*BAL*) will prevent vesication and systemic poisoning if applied quickly, but is too toxic to be given in large doses, so that it does not fulfil all the requirements given above. We therefore sought a detoxicated thiol, using the principle[4] that detoxication and renal excretion are both enhanced by reducing the ease with which a substance can penetrate into cells. This reduction can be achieved by introducing polar groups, such as OH or COOH, into the molecule, thereby satisfying requirements 2 and 5. In theory, such a detoxicated thiol could be given intravenously in large amounts and, apart from renal excretion, would remain in the blood and intracellular fluids, penetrating into cells only very slowly, thereby satisfying requirement 1. This thiol, being present in high concentration in the blood, would trap any arsenic in the blood and prevent its penetration into cells. Moreover, although the detoxicated thiol may be unable to diffuse into cells, yet the intracellular arsenic must be partly dissociated and so able to diffuse out of cells into the blood, where it would be trapped by the thiol. It was therefore plain that modification of the structure of thiols in the light of our knowledge of cell permeability would give a therapeutic agent satisfying all the requirements 1 to 5.

Accordingly, two of us (L. N. O. and G. S.) undertook the synthesis of some substances with these properties. In a few months, several such thiols became available, so that it was possible to test the therapeutic activity of glutathione, a number of thiol

dicarboxylic acids, thioglucose and the O-glucoside of dithioglycerol[1]. The last of these compounds, given the name *BAL-Intrav*, proved to be the most promising, and has now been shown to have the following properties: (1) The lethal dose ($L.D._{100}$) to rats is about 7·5 gm. per kilo. (2) It penetrates very slowly into cells, so that its effective distribution in the body is in the blood and intercellular fluids. It is rapidly excreted in the urine. (3) At a dosage of 1–2 gm. per kilo it causes no pathological symptoms in rats, rabbits, guinea pigs or goats, other than a transient increase in rate of respiration. (4) With all four species it gives marked protection against systemic lewisite poisoning. (5) With rabbits, which were studied in most detail, a total dosage of 1·5 gm. per kilo of *BAL-Intrav* administered by intravenous injection at intervals over 6 hours will give complete protection against 3–4 times the $L.D._{50}$ of lewisite, even when four hours elapse between contamination and commencement of treatment.

The lewisite dosage (three to four times the $L.D._{50}$) in the case of rabbits was approximately an $L.D._{95}$, that is, it killed 95 per cent of the animals in the absence of therapy. The animals died between 10 and 48 hours after contamination. If treatment was delayed for 6½ hours after contamination, about 50 per cent of the animals could be saved. It was thought that the mortality of 50 per cent when therapy was delayed for 6½ hours might be due to tardy removal of arsenic from intracellular sites. It seemed likely that the rate of removal could be increased by giving a small amount of a cell-permeating thiol, such as dithioglycerol (*BAL*), which could act as a carrier of arsenic between the cell and the *BAL-Intrav* in the blood. This proved to be the case; a dose of 4 mgm. per kilo of *BAL*, when given with a high dosage (1–1·5 gm. per kilo) of *BAL-Intrav*, reduced the mortality under the conditions given above to 25 per cent when treatment was delayed for 6½ hours after contamination. A dose of 4 mgm. per kilo of *BAL* produces only transient signs of toxicity, and when given without *BAL-Intrav* did not reduce mortality at all[2].

Prof. R. A. McCance and Dr. E. M. Widdowson have kindly made intravenous injections of *BAL-Intrav* into a number of men, observing no ill effects with a dose of about 100 mgm. per kilo, given as a single intravenous dose. The maximum permissible single dose of *BAL* is 4 mgm. per kilo, at which level some pathological complications appear. (This dose may, however, be repeated at intervals of four hours.)

Those engaged on this problem are deeply indebted to many friends at Oxford, Cambridge and at the Ministry of Supply, both in London and at Porton: the list of names involved is too long to mention here, but an exception must be made in the case of Prof. G. R. Cameron, without whose sympathetic advice and generous practical assistance we should not have accomplished this work. This work was commenced while three of us (J. F. D., M. D. and P. D. M.) were members of a team under the administration of Dr. M. Dixon. We are indebted to the Chief Scientific Officer, Ministry of Supply, for permission to publish this report.

[1] Cameron, Short, Mitchell and Danielli. Report to Ministry of Supply, 1943.
[2] Mitchell, Danielli and Short, Report to Ministry of Supply, 1944.
[3] Peters, Stocken and Thompson, *Nature*, **156**, 616 (1945).
[4] Danielli, in "Cytology and Cell Physiology" (ed. Bourne, 1942).
[5] Danielli, Danielli, Mitchell, Owen and Shaw, Report to Ministry of Supply, 1944.
[6] Danielli, Jones and Mitchell, Report to Ministry of Supply, 1945.

AMERICAN WORK ON *BAL*

THE brief review in these columns (*Nature*, **156**, 616; 1945) by Peters, Stocken and Thompson giving the history of the discovery and outlines of work upon 2:3 dimercaptopropanol (*BAL*, or British anti-lewisite), has now been amplified by a statement from the United States (*Science*, **102**, 601; 1945) ably compiled by L. L. Waters and Chester Stock. In the previous article, the main facts were given of the biochemical work leading up to this discovery, and the evidence was briefly summarized for the view that vicinal dithiols are effective antidotes to arsenic through their ability to form ring compounds with trivalent arsenicals, permitting thereby the excretion of increased amounts of arsenic from the system. In the American review, an account is given of the intense programme of study undertaken jointly by various U.S. Government agencies into the preparation and manufacture, biochemistry, toxicology, pharmacology, experimental therapeutics and clinical application of the new discovery.

In addition to confirming and extending the fundamental British observation, American workers have shown how trypanosomes and spermatozoa poisoned with arsenic can be revived by dithiols of *BAL* type, with presumptive elimination of the arsenic. They have studied in detail the action of *BAL* as a reducing agent, finding that it converts methæmoglobin instantaneously to hæmoglobin, and in the presence of oxygen will open the porphyrin ring. Among the pharmacological facts recorded, it has been found that lethal amounts of *BAL* cause an intense vasoconstriction in skin and skeletal muscle with early transient rise in blood pressure; there is also a reduction in *p*H of the blood. In an analysis of the toxicity of the compound when injected in amounts approaching a lethal dose, it was also shown that by keeping cytochrome *C* in a reduced condition it can interfere with cytochrome oxidase activity, and that oxidized *BAL* can act as an inhibitor of enzymes containing —SH groups essential for their activity.

It is perhaps worth stressing that, despite these toxic actions produced by high concentrations of the drug, *BAL* dissolved in peanut-oil has now been injected safely and with favourable results into a large number of patients suffering from arsenical dermatitis both in Great Britain and in the United States. It is stated that animal experiments have shown that *BAL* can prevent the development of pulmonary lesions not only after the inhalation of lewisite, but also after cadmium and zinc fumes; and that it is also active against the systemic action of mercury. Preliminary therapeutic trials in mercury poisoning have been encouraging. The detailed publications will be awaited with interest.

OBITUARIES

Sir Farquhar Buzzard, Bart., K.C.V.O.

SIR FARQUHAR BUZZARD died at Oxford of coronary thrombosis on December 17 in his seventy-fourth year. Like his father, Dr. Thomas Buzzard, of the National Hospital, Queen Square, he was a distinguished neurologist. After graduation from Oxford and St. Thomas's Hospital, he became house physician at Queen Square to the great Hughlings Jackson, an old friend of his family. He was elected to the staff at Queen Square in 1905, and later to St. Thomas's.

His published contributions to neurology consist of a well-known book on the "Pathology of the Nervous System" (with J. G. Greenfield) and numerous articles and lectures on clinical subjects, including the Goulstonian and Lettsomian Lectures and the Harveian Oration. These reveal him as a keen clinical observer, with a deep understanding of the psychological aspects of illness. He was, indeed, a pioneer among organic neurologists in recognizing the importance of minor psychological ailments and their relationship to the major psychoses, at a time when it was considered at Queen Square that a neurologist ought not to concern himself with the functional side of neurology. His opinion on difficult cases was much sought, for he had to a marked degree the qualities of a good consultant: he was imperturbable yet sympathetic, direct and honest with patient and medical man alike—and with himself in his own unobtrusive way; and he had a strong constitution and great physical and moral endurance.

In 1928 at the height of his fame as a London consultant, Buzzard succeeded Sir Archibald Garrod as regius professor of medicine at Oxford, a position which he held for the next fifteen years. He had expected to be able to continue some consultant work from Oxford, but soon found this impossible. He served on the Hebdomadal Council and on numerous University committees, and was chairman of the honorary medical staff committee and later vice-president of the Radcliffe Infirmary. In these various capacities he notably influenced University policy in general, and the development of the medical school in particular.

In administrative affairs his talents lay rather in the field of conciliation and in giving cohesion to the ideas of his colleagues than as an originator. He was the engineer of Lord Nuffield's medical benefactions, the Institute of Medical Research (1935) and the scheme for enlarging the scope of the medical school (1937). It was under his guidance that an undergraduate clinical school was opened at the outbreak of war when Oxford students had nowhere else to go for clinical instruction. He was the first chairman of the medical committee of the Nuffield Provincial Hospitals Trust, and was largely instrumental in directing its activities into the field of social medicine. In committee he could be slow and even ponderous (a manner occasionally belied by a quick flash of wit), and his patience was inexhaustible; the only sign of anger was a slight flushing of his sturdy neck and a steely glint of his eyes. He was reserved, perhaps more taciturn than the ideal University democrat, and for all his rugged honesty he was not without his moments of artfulness (as was most evident on the tennis court); but he retained to the end of his life a great tolerance and understanding of younger men, and was generously loyal to them even when they contrived to hurt his feelings.

The University of Oxford awarded Sir Farquhar the Osler Memorial Medal, he was an honorary fellow of his old college Magdalen, and after his retirement in 1943, honorary student of Christ Church; he was Extra Physician to H.M. the King and had many honours.

His last year was characteristic of him: in his work for the Hospitals Trust, though beginning to feel his years, he travelled the country in more discomfort than most men of his age would have supported. A severe heart attack in the late summer was met with his customary stoicism, his one fear being that he might live and yet not be able to work. He died suddenly before the fear was realized. H. CAIRNS.

Dr. L. Cernosvitov

THE sudden death of Dr. Lev Cernosvitov on December 15 came as a sad shock to his friends and colleagues. He was well known as a specialist on Oligochæte worms, a group which he had made his own and on which he had produced a body of work of the highest standard.

Lev Vladimirovich Cernosvitov was born in Poltava in July 1902. A few years of his early childhood were spent in Paris, where his father, a member of the legal profession, was in exile for revolutionary activities. The family were back in Russia, however, for his school years, which were interrupted by the revolution of 1917. In 1920, at the age of eighteen, he escaped to Constantinople; and two years later he was taken, with a number of other Russian youths, to Prague, where he received his higher education, taking his doctorate in zoology in 1927.

Cernosvitov's first paper on Oligochætes was published in 1925 in collaboration with Sergej Hrabě, and from then on a steady stream of papers on this group came from his pen. Much of the material described was collected by himself in Czechoslovakia, in the Carpathians, in the Balkans and in South America. The American collections were made during 1931–32 when Cernosvitov was engaged in work on the control of insect agricultural pests, and the three interesting papers on this material that appeared in 1936, 1937 and 1942 were to have been followed by a more comprehensive work when opportunity allowed. On his return from South America, besides having to earn his living by more utilitarian tasks (experimental transplantation of teeth of mice in a dental clinic, field-work for the biological control of the spruce saw-fly, etc.), Cernosvitov was now much in demand to report upon the Oligochæte collections of many expeditions and European museums. His connexion with England occurred in a double capacity. His work on spruce saw-flies was done for the Imperial Institute of Entomology, and, after Colonel J. Stephenson's death in 1933, we looked to him for all expert work on Oligochæta. The late Rev. Hilderic Friend sent him his collections of Enchytræidæ, upon which Cernosvitov reported in 1937. The late Charles Monro, who had charge of the annelid worms at the British Museum (Natural History), was very anxious to attach him to the Museum staff as Oligochæte specialist. In 1945 he was elected fellow of the Linnæan Society.

When war broke out in 1939, Cernosvitov was pursuing saw-fly parasites in Finland. He hurried to London, and until July 1940 was working at the Museum. Owing to war conditions, he then had to accept a post as monitor at the B.B.C., where his linguistic attainments were of value. With great determination he kept in touch with 'his worms'. He spent one of his short holidays at Bangor, where his first contact with the teeming life of the intertidal zone gave him a thrill similar to that he experienced on first meeting the tropical fauna. In 1943 he spent a couple of weeks at the Freshwater Biological Association's station on Windermere. The collections made there were later worked out at the University of Reading in his free time from B.B.C. duties, and a paper on them appeared in the *Proceedings of the Zoological Society* of 1945. This work, and a revision of Friend's types published in 1942, put British Oligochæte studies on a sound basis.

In addition to his anatomical and taxonomic work,

Cernosvitov made a detailed investigation of the resorption of spermatozoa in the Oligochæta (1930) and the Turbellaria (1931 and 1932), and in 1930 he published a critical review of the literature of this subject for the animal kingdom in general. He concluded that the phenomenon was of widespread and normal occurrence, and speculated as to its physiological role. From this he took a special interest in the little-explored field of hormones in the Invertebrata.

In Dr. Cernosvitov we lose not only an able zoologist, but also a colleague of singular personal charm. He married, in 1944, Miss Nina Gartman, who is of Russian birth but British nationality, with whom all who knew him must feel the keenest sympathy. Sympathy must be felt too for his mother and brother, now in Paris, for whom the shock of his death is added to the dreary war years of uncertainty and separation. E. TREWAVAS.

Dr. Thomas Barbour

BY the death of Thomas Barbour on January 8 at Boston at the age of sixty-one, the result of a stroke, the United States loses one of its leading biologists and Harvard one whose name will always be associated with the great Agassiz Museum. He was a member of the U.S. National Academy of Sciences; while bodies outside the United States which had honoured him included the Zoological Society of London, which made him a foreign member.

In early life Barbour was closely associated with the Agassiz family, but his inclinations led him mainly to the study of land animals in relation to their environments. Few knew Florida so well, for his family had lived in the Everglades in friendship with the Seminole Indians, in a quite unopened country, shell and pottery mounds, swamps, forests, islets and mangrove swamps. He knew the Miami River as an almost uninhabited area, and for all his life fought to preserve Nature in this sole tropical area of the States. He visited it yearly and helped to found its University and Marine Research Laboratory.

Barbour passed an extended honeymoon, wandering, collecting and observing from Burma and Indo-China to New Guinea. On his return he settled in Boston and commenced his long series of systematic publications incorporating his field observations, principally dealing with the reptiles. He led several fossil 'digs' and wandered over most of the West Indian islands.

During the War of 1914–18 he was sent with a commission to cement a most doubtful friendship with Cuba, its temperament so different from that of Latin-America. Physically he was a very big man, a demon for work, vivacious, with a great capacity for friendships. He commenced a life-long attachment with that remarkable naturalist Carlos de la Torre, at one time president of the Republic, and was received informally and joyously by the intelligentsia all over the island, while everywhere researching and collecting its fauna. He specialized on birds, and from his notes grew the standard work on those of Cuba. Every winter he visited the island, and his support was sought for every educational development. He helped in the growth of the great Soledad gardens and established its important, and much-visited, Harvard House. Other activities in this region were at Panama and Miami; and he visited and advised upon the Kruger National Park in the Transvaal.

A man is perhaps best seen in his miscellaneous writings: Barbour's were "The Naturalist at Large", "That Vanishing Eden", "A Naturalist in Cuba", all written in partial retirement, old-fashioned in form but entirely modern in outlook. The man was a delightful personality and he made a grand time living his life. He was a friend to all science in the States, and a host to visitors to Harvard.

J. STANLEY GARDINER.

Dr. E. J. H. Mackay

THE Watumull Prize for 1945 of the American Historical Association, offered for works dealing with the history of India and published during 1941–44, has been awarded to the late Dr. Ernest Mackay for his last archæological report, "Chanhu-daro Excavations, 1935–36", a fitting tribute to a long career of valuable archæological field-work. Unhappily, the award must be a posthumous one, for Dr. Mackay died on October 2, 1943, at the age of sixty-three, through the strain of four years of service as an A.R.P. warden.

Dr. Mackay began his life's work under the ægis of the late Sir W. Flinders Petrie, one of whose greatest services to archæology was the training of almost an entire generation of British excavators who have worked in Egypt and Western Asia. After nearly four years of work for Mr. Robert Mond among the Tombs of the Nobles at Luxor, Mr. Mackay served with the Egypt Expeditionary Force in Palestine and Syria, and in 1919 was British member of the International Commission appointed by Lord Allenby to survey and list the Holy Places and sites of archæological interest in those countries for their protection and preservation.

After an interval as 'custodian of antiquities' in Palestine, Dr. Mackay went to Iraq in 1922 as the first field director of the Oxford University and Field Museum, Chicago, Joint Expedition to Kish; and in March 1925 he discovered the small but important mounds of Jemdet Nasr, a key site for the early history of Sumer. A call to assist with the excavations of the Archæological Survey of India at the great Indus Valley site, Mohenjo-daro, took him to India in 1926, and when the financial crisis of the early thirties compelled the abandonment of active excavations, he compiled his "Further Excavations at Mohenjo-daro, 1927–31", two volumes, a fine sequel to the great three-volume work, "Mohenjo-daro and the Indus Civilization", published in 1931, in which he collaborated with Sir John Marshall and others.

During 1935–36, under the joint auspices of the American School of Indic and Iranian Studies and the Boston Museum of Fine Arts, Dr. Mackay excavated Chanhu-daro, Sind—a site which produced evidence of two cultures subsequent to the Harappa culture (of the city of that name and Mohenjo-daro), a first step towards bridging a long dark gap (*c.* 2500–1500 B.C.) in the history of India before the coming of the Aryans.

As the only field archæologist to have excavated in all the three great river valleys—the Nile, Euphrates and Tigris, and the Indus—chief centres of early civilization in the ancient world, Dr. Mackay's numerous volumes and articles are of especial value for their wide appreciation of the contacts between the ancient peoples, racial, of art and religion, and by trade.

Mr. R. E. Turner

By the death of Rowland Edwards Turner on November 29, 1945, at Mossel Bay, Cape Province, at the age of eighty-two, the British Museum (Natural History) has lost a friend who worked voluntarily for the Department of Entomology for more than thirty years. During the First World War, he laboured in the Hymenoptera Room to build up the first arranged national general collections of Braconidæ and of the sphecoid and vespoid families then collectively known as 'Fossorial Hymenoptera'. He soon became a recognized authority on the Thynnidæ and contributed the part of Wytsman's "Genera Insectorum" devoted to that family.

In the inter-war period, Turner spent almost his whole time collecting for the Museum, in tropical Queensland, in western and other parts of Australia, in Assam, but most of all in South Africa. He collected and presented to the Museum more than 850,000 specimens, mostly Hymenoptera but also representatives of Coleoptera and other orders, specializing in the obscurer forms neglected by others. The main mass of this vast collection remains as a priceless store of material for present and future workers to investigate; for, unlike many collectors, Turner took great care that his material should be in the most perfect condition possible. No doubt countless undescribed genera and species are represented in this sample collection, but among the numerous discoveries already made known might be mentioned the new hymenopterous family Dinapsidæ which he discovered in South Africa. Furthermore, he found time to write 125 papers, mostly to describe new genera and species of Fossorial Hymenoptera he had collected himself.

After his mother's death, Turner married her nurse, who now survives him. He was very shy and had an impediment in his speech, but was of such a sweet temperament that he had no unkind words for others, or they for him.

Robert B. Benson.

NEWS and VIEWS

American Academy of Arts and Sciences and International Co-operation

At its January meeting, the Council of the American Academy of Arts and Sciences, the second oldest learned society in the United States, adopted the following resolution: "Believing that the peace of the world and the advancement of the arts, the sciences, and education in all countries can be effectively furthered by an active support of the United Nations Educational, Scientific and Cultural Organisation, the Council of the American Academy of Arts and Sciences congratulates the Senate and House of Representatives of the Congress of the United States upon the several resolutions adopted by them favoring support of this organisation, and urges upon the Congress the desirability of ratifying the charter of the organisation on the basis of the signature of our representatives at the London Conference last November".

Control of Atomic Energy: Chinese Views

Dr. Joseph Needham, of the British Council Cultural and Scientific Office, Chungking, invited representative Chinese bodies to make statements on the use and control of atomic energy. The Chinese Physical Society believes that the United Nations Organisation should appoint a commission on atomic energy to ensure that its applications are developed solely towards peaceful objectives; the proposed commission should organise world-wide inspection, and also an international laboratory, which would be a centre of research on fundamental problems, open to qualified men of science of all nations. The Science Society of China, which is comparable with the British Association in function, deplores the use of atomic energy for weapons of war, and makes the point that, if the benefits of the use of atomic energy are to be extended to all peoples, it is unjustifiable for any nation or group of nations to keep a monopoly on such information. It believes that all knowledge relating to atomic energy should be under the control of the Security Council of the United Nations Organisation. The Natural Science Society of China and the Chinese Association of Scientific Workers point out that the control of atomic energy by individual nations imposes conditions on scientific workers involved which are inimical to freedom of research, expression and communication, and that national direction of such research would hinder development. It is therefore suggested that an international conference to discuss the problem, under the auspices of the Security Council of the United Nations Educational, Scientific and Cultural Organisation, should be summoned as soon as possible; and that a group of men of science of many nations should take part in the control of the application of atomic energy.

United Nations Educational, Scientific and Cultural Organisation

The United Nations Educational, Scientific and Cultural Organisation has come one step nearer as a result of the fourth session of the Preparatory Commission held in London during February 11 and 12. Under the chairmanship of Miss Ellen Wilkinson, British Minister of Education, and of Mr. Donald Stone, U.S.A. delegate, the Commission considered a wide field of suggested activities. As at present envisaged, the Organisation consists of the following committees: A, Humanities and Sciences; B, Education; C, Media of Mass Communication; D, Libraries, Museums, Exchanges, Publications, Special Projects; E, Organisation Issues. Some of these committees are subdivided again into sub-committees; thus Committee A has sub-committees on philosophy, arts, social sciences and natural and pure sciences. The sub-committee on natural and pure sciences is to review and make recommendations upon international co-operation in the field of those sciences. The sub-committee on social sciences will be responsible for planning activities, including the interchange of men and ideas, in those sciences, their application to contemporary international problems, the organisation of international study conferences and institutes, etc. Committee B (Education) will deal with matters relating to education at all levels, including adult education. It may be necessary for this committee to establish *ad hoc* sub-committees, but it was felt that in order to emphasize the continuity of the educational process, from the nursery school to the

university and beyond, as much as possible of the planning should be done by the committee as a whole. The Preparatory Commission is still awaiting the ratification, or at least the acceptance, of its charter by a sufficient number of Governments, before the secretariat can move to its permanent headquarters in Paris. Great Britain and Belgium have already accepted the constitution of the United Nations Educational, Scientific and Cultural Organisation, and the United States are expected to do so in the very near future.

A 'UNESCO Month', during which lectures, exhibitions, films, etc., would emphasize the value of international cultural co-operation, has been agreed upon as an important early feature by the United Nations Educational, Scientific and Cultural Organisation; it is to precede the annual conference which, according to its constitution, the Organisation must arrange every year in a different country. These meetings will be organised to bring about the right atmosphere in the host country, and to provide discussion at the highest level on current intellectual and spiritual problems. The host country would be stimulated to mobilize its best intellectual and artistic resources to enable the Conference to start its proceedings in a spirit attuned to the nature of its task. It is not intended that this 'UNESCO Month' should deal exclusively with the culture of the host country; leading authorities in other countries would no doubt co-operate in this work of international understanding. This scheme, which was put forward by Sir Alfred Zimmern, was approved by the Preparatory Commission. The first 'UNESCO Month' will probably be held in Paris next autumn.

Biological Risks of Atomic Fission

An interesting and possibly very important biological problem has been emphasized by Dr. B. P. Wiesner (*Lancet*, 33, Jan. 5, 1946). Referring to the account of American work on the development of means of using atomic energy for military purposes, written by Prof. H. D. Smyth (H.M. Stationery Office, 1945), Dr. Wiesner points out that the questions involved are not merely political and social, as this report suggests, but are biological problems which cannot be solved by political or social control. The use of nuclear fission on a large scale, even if it be used only for industrial purposes, involves the important biological effects of the intense radioactivity which is produced by nuclear fission. Protective measures were adopted in the American plants, and similar measures will be required if nuclear fission is used for industrial purposes. Dr. Wiesner, however, urges that there are other effects which have not been adequately considered. Radiation may affect the gametes and their development; it does not necessarily prevent spermatogenesis or fertilization, but it may cause early fœtal death. It may also cause genetic changes which have been studied in insects. The possibility of the occurrence of this kind of effect should, Dr. Wiesner urges, be discussed in public and not only by committees of experts briefed by their governments. The public must be allowed to have all the information that any expert can give. It will then be able to decide whether it will allow the application of nuclear fission to industry.

Dr. Wiesner's letter is followed by another by Mr. Kenneth Walker (*Lancet*, 69, Jan. 12, 1946), whose surgical experience and association with Dr. Wiesner in the study of male infertility will ensure adequate consideration of his views. We are, he reminds us, planning to make use of a force which has a profound influence on living tissues and more particularly on the cells responsible for the continuation of the race; and there is no excuse for postponing the study of the effects of this force. Much work has been done on the effects of X-rays and radium on tissue cultures and on the structure of the testes, and on the protection of workers against these effects; but hospitals use only a few milligrams of radium, while the radioactive material produced by nuclear fission will be the equivalent of thousands of grams of radium. Mr. Walker also raises another important and related question. He is not satisfied that the possible reasons for the known high incidence of sub-fertility in otherwise healthy males have been adequately investigated. He finds it difficult to account for this sub-fertility without postulating the existence of some undiscovered factor in our industrial civilization which injures the germ-plasm. He therefore urges that the medical profession should not wait until the industrialists have completed their plans before it starts to study the possible biological consequences of the industrial use of atomic energy. This investigation is surely not a responsibility of the medical profession only. It is a public responsibility of other biologists also to find out whether risks to the continuance of the human race are involved and, if any are, to give the public all the information about them that can be obtained.

Theoretical Physics at Oxford: Prof. M. H. L. Pryce

Prof. M. H. L. Pryce, fellow of Trinity College, Cambridge, has been appointed to the newly reconstituted Wykeham chair of theoretical physics in the University of Oxford; he will take up the appointment next Trinity term. Prof. Pryce was educated at Cambridge, and later spent three years at the Institute of Advanced Studies, Princeton, with a Commonwealth fellowship. During the first part of the War he worked under the Admiralty in the Signal Establishment, later being transferred to Montreal to work with the 'Directorate of Tube Alloys'. His publications before the War included papers on non-linear electrodynamics, and Dirac's theory of radiation.

Industrial Metallurgy at Birmingham: Appointment of Dr. Leslie Aitcheson

A chair of industrial metallurgy established at the University of Birmingham has been filled by the appointment of Dr. Leslie Aitcheson. Hitherto, the Department of Metallurgy has been mainly concerned with the production of men trained for research in the subject. Now the position is changing somewhat. To quote from the Vice-Chancellor: "The development of manufacturing processes, recently an art, has now become an exact science and calls for men of the highest ability, who are needed at all levels of the modern manufacturing business, in administration, in all branches of production, management and control. Such men are necessary if the results of research are to be used effectively in the production of metals and alloys of the requisite quality at an economic price". Such men would have the same basic training as those intended for research as a career, but in addition they must be introduced to aspects of manufacture that have not hitherto been dealt with in degree courses in metallurgy. Dr. Aitcheson, who was educated at the University of Sheffield, has had wide practical experience, having

been engaged, among other activities, as consulting metallurgist to the Air Ministry, the Association of Drop Forgers and Stampers, and various motor firms in the Birmingham district. In addition, he has written extensively on metallurgical subjects. The creation of the chair has been welcomed by many leading industrialists.

Chemistry at University College, Leicester: Prof. L. Hunter

As a consequence of the recognition of University College, Leicester, by the University Grants Committee, the College Council is proceeding to strengthen the teaching staff by the appointment of professors and additional lecturers. Among a number of appointments is that of Dr. L. Hunter to the chair of chemistry. That chemistry should be chosen for one of the first professorships to be established at Leicester is a tribute to Dr. L. Hunter's work as head of the Chemistry Department. Appointed in 1925 to found the Department, Dr. Hunter devoted his first years in Leicester to establishing and consolidating it. Even during those difficult years, and working under a heavy burden of teaching, he never lost sight of the value and importance of research work in any virile teaching department. In translating this ideal into a reality, Dr. Hunter met many difficulties, not the least being the lack of post-graduate scholarships in so young a college. Surmounting these in many novel ways, Dr. Hunter succeeded in establishing a vigorous and steadily growing research school which consisted, immediately prior to the War, of some ten post-graduate research workers. In this work he was loyally supported by his first assistant, Dr. A. Hickling, who is now lecturer in electrochemistry in the University of Liverpool. Even during the difficult years of war, Dr. Hunter's department maintained a steady though reduced output of original work. Dr. Hunter and his co-workers have made important contributions to the chemistry of the hydrogen bond, particularly as it concerns molecular association and tautomerism, and to the chemistry of chelate metallic derivatives of organic compounds. Coming to Leicester from the University College of North Wales, Bangor, he was versed in the traditions of the late Prof. Kennedy Orton's school of chemistry, and his earlier published work concerned the use of chloroamines in the stepwise halogenation of organic compounds.

Exhibition of German Aeronautical Developments

THE exhibition of German aeronautical developments, with which the Science Museum, South Kensington, is re-opened, is the result of the great interest taken in a much larger one held at the Royal Aircraft Establishment, Farnborough, during the autumn of 1945. This was confined to invited guests, for obvious reasons, and although these invitations were very widely distributed it was felt that there was still a number of students of aeronautics, in its various aspects, who could profit by it. Limitation of space has necessitated reducing the exhibits, especially the complete aircraft, but as wide a choice in types as possible has been made. Many of the exhibits are sectioned and shown in the 'exploded' form, liberally supplied with explanatory show cards. There are a few exhibits of British work by way of comparison, and an excellent display of photographs, arranged comparatively, German and British.

The aircraft range from gyro-controlled kites, pilotless aircraft, rockets, to the small fighter aircraft. The engine section has various types of piston engines, and a comprehensive display of gas turbines and jet propulsion units in several forms. Instruments and general equipment occupy some of the galleries, and there is a special display of aircraft armament. The general layout of the exhibition is well thought out, and it should be of great help to the student of aeronautics, who has necessarily not had the opportunity of keeping abreast of the developments in the many different aspects of the science during the war period. A catalogue is available that is not only a guide but also contains much technical information supplementing that given on the show cards. The catalogue invites further inquiries from anyone genuinely interested, which will be answered, so far as further data is available, by the Director, Royal Aircraft Establishment, South Farnborough, Hants.

'Flavazole', an Effective New Antiseptic

YET another new series of compounds has been added to the growing list of antiseptics. Prof. J. McIntosh and his collaborators (*Lancet* of July 28, p. 97) report upon their trials of 'Flavazole', which is a chemical combination, in equimolecular proportions, of sulphathiazole and proflavine base. This represents a new type of acridine compound, which has been introduced by the research laboratories of Messrs. Boots Pure Drug Co., Ltd., and it is claimed to be an advance on the mixtures of one part of proflavine and 99 parts of sulphathiazole, widely used in powder form in the Army and in industry for the first-aid treatment of wounds. These new compounds are neutral or slightly alkaline in solution and are less irritant than their acridine components. *In vitro* tests have shown that they "have lost none of the bacteriostatic powers of their components". Comparison of the action of 'Flavazole', sulphathiazole and proflavine upon "all types of organisms likely to be found in wounds" (including the Clostridia which cause gas gangrene) shows that the bacteriostatic power of 'Flavazole' is greater than that of either of its components, especially against Gram-negative bacilli. It has slightly more activity against *Pseudomonas pyocyanea* and *Proteus*.

Clinical trials of 'Flavazole' have shown that it can be safely used in the conjunctival sac and in any infected cavity as a wound antiseptic. Used as a powder composed of 2 per cent 'Flavazole' and 98 per cent of sulphathiazole, it will control mixed infections in wounds. Dusting with this powder led to the disappearance of bacteria within three days. The severe test of treatment in a spinal unit of pressure sores and other wounds which were heavily infected with pyogenic cocci and Gram-negative bacilli showed that 'Flavazole' greatly reduced these infections. 'Flavazole' is not irritating, and is safer than proflavine. The dilution of penicillin with the powder just mentioned provides "a highly-potent antibacterial power with a wide range of activity against all bacteria likely to be found in wound sepsis".

Conference on Fundamental Particles and Low Temperature Physics

THE Physical Society, in collaboration with the Cavendish Laboratory, is holding a conference at Cambridge under the combined title of "Fundamental Particles" and "Low Temperature Physics" during July 22–27. One day of the conference is to be devoted to the formal opening of the new Austin Wing of the Cavendish Laboratory, and to lectures

and demonstrations illustrating the work of the Laboratory. Delegates to the conference are being invited from abroad as well as from the British Isles, but considerations of space may limit the total number of visitors. Those who wish to attend should therefore apply to the conference secretary, J. F. Allen, Royal Society Mond Laboratory, Cambridge.

Radiolocation Convention

A RADIOLOCATION CONVENTION is to be held during March 26–29 at the Institution of Electrical Engineers. At the opening meeting a lecture on the evolution of radiolocation will be given by Sir Robert Watson-Watt. Separate sessions will be devoted to aerials and wave-guides, propagation, cathode ray tubes, valves, radio measurements and test gear, transmitters and receivers, and circuit techniques. Lectures will be given by Mr. W. A. S. Batement on precision radar, by Mr. A. W. Ross on shipborne radar, and by Dr. R. A. Smith on radar in navigation.

Earthquake in Algeria

AT approximately 2.46 a.m. on Tuesday, February 12, an earthquake of considerable intensity affected districts in Northern Algeria, south-west of Constantine. As a result of the shock, considerable damage was done, roads were blocked and communications cut, and it is reported that 276 people were killed and 70 seriously injured. An earthquake occurred in Algeria near Mostaganem on April 1, 1939, and was reported in *Nature* of July 15, 1939. Previous earthquakes were reported in *Nature* of June 3, 1933.

New Comet

A NEW comet was discovered by Timmers at the Vatican Observatory on Feb. 2d. 0h. 10·9m. U.T. Its magnitude was 9 and its tail was less than 1° in length. Its daily motion was given as R.A. – 1m. 41s., Dec. + 1° 12′. The comet was observed by Dr. W. H. Steavenson at Cambridge on Feb. 10d. 21h. 16·8m. Its position then was R.A. 9h. 30m. 13·3s., Dec. + 52° 11·5′. Sufficient observations are not yet available to compute an orbit.

T Coronæ Borealis

THIS star, which appeared as a so-called nova in 1866 and then faded to magnitude 9, was observed by Mr. N. F. H. Knight on Feb. 9d. 5h. 30m. to have a magnitude 3. It appears to be fading now, as later observations by Mr. W. M. Lindley, Mr. F. M. Holborn and Dr. W. H. Steavenson give its magnitude as about 3·5. It has also been observed at Yerkes; the velocity of expansion has been estimated to be 4,000 km. per second.

The Night Sky in March

NEW moon occurs on March 3d. 18h. 01m. U.T. and full moon on March 17d. 19h. 11m. The following conjunctions with the moon take place: March 4d. 20h., Mercury 6° N.; March 12d. 11h., Mars 1° N.; March 12d. 14h., Saturn 2° S.; March 20d. 01h., Jupiter 3° S. In addition to these conjunctions with the moon, the following conjunctions occur: March 18d. 08h., Mercury in conjunction with Venus, Mercury 5° N.; March 19d. 01h., Mars in conjunction with Saturn, Mars 3° N. No occultations of stars brighter than mag. 6 occur during the month. Mercury is visible in the western sky in the first portion of the month, setting nearly 1½ hours after the sun. Venus is conspicuous in the western sky, setting at 18h. 04m., 18h. 49m., and 19h. 41m. at the beginning, middle and end of the month respectively. Mars, in the constellation of Gemini, can be seen during the greater part of the night and does not set at the end of the month before 3h. 19m. Jupiter is well placed for observation, rising at 21h., 54m., 20h. 54m., and 19h. 40m. on March 1, 15 and 31 respectively. Saturn is easily recognized close to Mars, a conjunction of the planets taking place on March 19. The planet is stationary on March 20. Spring equinox occurs on March 21d. 06h.

Announcements

DR. JULIAN S. HUXLEY has been appointed executive secretary of the Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation.

SIR HAROLD SPENCER JONES, Astronomer Royal, has been elected a member of the Athenæum under the provisions of Rule II of the Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services.

PROF. A. R. TODD, professor of organic chemistry in the University of Cambridge, will deliver the Pedler Lecture of the Chemical Society on March 7, taking as his subject "Synthesis in the Study of Nucleotides".

THE *Quarterly Journal of Microscopical Science* was edited by Ray Lankester (with others at first) for fifty-two years, followed by the late Prof. E. S. Goodrich for twenty-six years. They are now succeeded by two joint editors: Dr. C. F. A. Pantin, reader in invertebrate zoology in the University of Cambridge, and Dr. John R. Baker, reader in cytology in the University of Oxford.

DR. J. F. T. YOUNG, associate professor of physics in the University of Manitoba, has been appointed professor and head of the Department of Physics in the University in succession to emeritus Prof. Frank Allen, founder of the Department (see *Nature*, 154, 456; 1944).

PROF. ANGELO M. DA COSTA LIMA, a distinguished Brazilian entomologist, has arrived in Britain in the course of a tour of the United States and Europe, sponsored by the Government of Brazil, and is visiting British entomological institutions. He has recently published the sixth volume of a work on "The Insects of Brazil".

THE Paul Lewis Laboratories, Inc., of Milwaukee, Wis., have established an annual award of 1,000 dollars and a bronze medal for outstanding research in enzyme chemistry, to be awarded by the American Chemical Society. Candidates for the award must be citizens of the United States less than thirty-six years old and graduates of an American college or university who are non-commercial chemists. The first award will be made in April.

THE English Group of the Nutrition Society has arranged a whole-day conference on "Nutrition in the Colonial Territories", to be held on March 2 at the London School of Hygiene and Tropical Medicine. Particulars can be obtained from the honorary secretary of the Society, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electrochemistry of Uranium

AN account of the polarographic reactions of the uranium ions has just been published[1]. During 1944, experiments on this subject were made at this Laboratory, the publication of which has been delayed by war conditions. In general, our results confirm those of Kolthoff and Harris. The first wave in the uranyl polarogram is due to the reaction

$$UO_2^{++} + e \rightleftharpoons UO_2^{+},$$

and the second 'wave' to a two-stage reduction from U V to U III. The American authors do not mention the fact that this second wave always shows a perceptible kink at half its height: the kink is more easily observed in sulphuric acid solutions, in which the first part of the wave has an irregular non-logarithmic form, and the second part something close to the logarithmic form of a reversible wave.

We have studied the oxidation waves of U III solutions in normal sulphuric and normal hydrochloric acids, as well as the reduction waves of U IV solutions described by Kolthoff and Harris, and find that the oxidation waves have nearly the same half-wave potentials as the reduction waves (− 0·94 v. in normal hydrochloric acid, and − 1·10 v. in normal sulphuric acid, both vs. the N.C.E.). Our values for the gradients of the log $\frac{i}{i_d - i}$ plots for these waves are nearer the theoretical value for one-electron transfer than theirs, but are nevertheless somewhat high, indicating that the reaction is not perfectly reversible.

Since, in agreement with the American workers, we find that none of the half-wave potentials of the uranyl polarogram varies systematically with the hydrogen-ion concentration, it is clear that none of the three successive reductions involves hydrogen ions, and therefore that a chemical step or steps of inverse hydrolysis must occur somewhere between the starting substance, UO_2^{++}, and the end product, U^{3+}. The first wave is certainly due to the reaction

$$UO_2^{++} + e \rightleftharpoons UO_2^{+};$$

the second wave could be due to a reaction such as

$$UO_2^{+} + e \rightarrow UO_2,$$

resulting in the formation of solid oxide or hydroxide at the electrode surface, at any rate in sulphuric acid solutions, where the wave is obviously caused by an irreversible reaction. This would be followed by the chemical step, giving rise to U^{4+} or UO^{++}, and finally the reaction

$$U^{4+} + e \rightleftharpoons U^{3+} \text{ or } UO^{++} + e \rightleftharpoons UO^{+}$$

(we consider the latter less likely) would be responsible for the third wave.

Reducing the free acid concentration of a hydrochloric acid solution of UO_2^{++} progressively at constant total chloride concentration causes the second uranyl wave to flatten and disappear, followed by the first. When the acidity becomes too low, the chemical reaction mentioned above would not take place fast enough, and the second part of the second wave would be eliminated; at still lower acidities, solid hydroxides would begin to be deposited on the dropping electrode in the first reduction.

Kolthoff and Harris suggest that, since the half-wave potential of the first uranyl wave (which is independent of acidity) is different from the redox potential of UO_2^{++}/U^{4+} mixtures as given by a platinum electrode (which varies with the acidity), the reactions at the platinum and mercury electrodes are probably different. This assumption does not seem necessary. We have established by experiments with a platinum micro-electrode that U^{4+} cannot be reversibly oxidized at such an electrode at any potential within the range that can be studied, so that the potential of a platinum electrode in uranyl-uranous mixtures is not the true reversible potential of a U VI/U IV equilibrium (as it was apparently taken to be by earlier workers). However, if the potential-determining reaction at a platinum electrode is the same as that at a mercury electrode, namely,

$$UO_2^{++} + e \rightleftharpoons UO_2^{+},$$

the observed Nernst equation dependence of the potential upon the various concentrations can be explained. We suppose that a mixed solution of UO_2^{++} and U^{4+} contains a small concentration of UO_2^{+}, maintained by the equilibrium

$$UO_2^{++} + U^{4+} + 2H_2O \rightleftharpoons 2UO_2^{+} + 4H^{+}$$

(representing the total of several reactions).

In a solution, 1 mole in each of UO_2^{++} and U^{4+}, and 1 *N* in H^{+}, the concentration of UO_2^{+} would be about 10^{-4} mole, calculated from the potentials. This concentration would vary in such a way with the concentrations of the other ions that the equation, established experimentally by Titlestad[2],

$$E = E_0 + \frac{RT}{2F} \ln \frac{(UO_2^{++})\,(H^{+})^4}{(U^{4+})}$$

is obeyed. However, E_0 here is not the true standard potential of the electrode reaction.

Our results agree with those of Kolthoff and Harris in showing that the first uranyl wave is due to a one-electron transfer. We have studied in more detail the interesting question of the ion of pentavalent uranium, probably UO_2^{+}, formed in this reduction. No solid salts of this ion are known, so it must be unstable. According to the idea stated above, the concentration of this ion can be determined approximately from the equation

$$E = E_0' + \frac{RT}{F} \ln \frac{(UO_2^{++})}{(UO_2^{+})},$$

where E is the potential of a platinum electrode in the solution, and E_0' the half-wave potential of the first uranyl wave: and changes in the UO_2^{+} concentration cause corresponding changes in the platinum electrode potential. In this way we have been able to follow the decomposition of UO_2^{+} formed in uranyl solutions by electrolytic reduction; we find that this reaction is of the second order in (UO_2^{+}), as expected, and that the rate varies with the acidity. In addition, we have shown that the concentration of this ion is increased above the equilibrium value by illuminating the solution, and that this fact is responsible for the potential-shift which a platinum electrode undergoes in the light in such solutions ("Becquerel Effect"; see Titlestad, *loc. cit.*). From studies of the activation energy of the disproportionation, however, we conclude that the potential-determining ion is probably not identical with the disproportionating ion, but that the concentrations of the two are in constant ratio to each other in a given solution, this ratio being a function of the acidity and temperature. For example, the ions might be UO_2^{+} (determining the potential) and $UO(OH)^{++}$ (disproportionating); these are interconvertible by hydrolysis or inverse hydrolysis.

It is not unlikely that unstable ions might be detected electrochemically in systems of the salts of other transition elements.

We hope to publish details of this work in the near future.

H. G. HEAL.

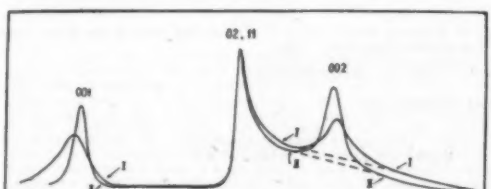
Montreal Laboratory,
National Research Council,
Canada.
Oct. 2.

[1] Kolthoff and Harris, *J. Amer. Chem. Soc.*, **67**, 1484 (1945).
[2] *Z. phys. Chem.*, **63**, 689 (1908).

The Clay Minerals Halloysite and Meta-halloysite

X-RAY studies of these minerals in relation to (*a*) their reactions with organic liquids (MacEwan), (*b*) the effect of heat treatment (G. W. B. and K. R.) have led us to certain conclusions which can best be expressed in a joint communication. Meta-halloysite has the same formula as kaolinite, $Al_2Si_2O_5(OH)_4$, and from the work of Hendricks and others[1] is generally considered to have a closely similar structure, consisting of layers of Si−O tetrahedra and Al−O,(OH) octahedra which in kaolinite[2] are arranged regularly above each other, but which in meta-halloysite are stacked with "considerable disorder"[1] or even, as we believe, with almost complete disorder as regards the orientation of the layers. In what follows we set out briefly the evidence for this view of the meta-halloysite structure.

In the first place, such a structure would be expected to give two types of line in an X-ray powder photograph: (i) 'crystalline' reflexions with indices (00*l*) having the usual symmetrical distribution of intensity, and (ii) lines from the two-dimensional layers with characteristic asymmetric intensity distribution with indices (*hk*). No reflexions should occur with indices (*hkl*). We find that all the reflexions from meta-halloysite, with the possible exception of a broad band between $d = 2{\cdot}56$ and $2{\cdot}33$ A., can be satisfactorily indexed as (00*l*) or (*hk*) with the following lattice parameters: $a_0 = 5{\cdot}14$ A., $b_0 = 8{\cdot}90$ A., $c_0 = 7{\cdot}2$ A. The reflexions to which (*hk*) indices are assigned all have the asymmetrical shape characteristic of those from a two-dimensional lattice (see figure). The band between 2·56 and 2·33 A., for certain meta-halloysites, appears to break up into four diffuse lines, two of which cannot be reconciled with this indexing and may therefore provide evidence for some degree of ordering in the orientation of the layers. We consider therefore that the essential character of the meta-halloysite structure is that it consists of randomly oriented sheets. Similar structures have been suggested for carbon black[3] and montmorillonite[4].



MICROPHOTOMETER RECORDS OF LOW-ORDER REFLEXIONS FROM NATURAL AND HEAT-TREATED META-HALLOYSITE, CURVES I AND II RESPECTIVELY.

Halloysite differs from meta-halloysite in having an additional $2H_2O$ per 'molecule' and consists, according to Hendricks[1], of the same layers which occur in kaolinite and meta-halloysite, with intervening layers of H_2O molecules. MacEwan[5] has shown that halloysite-organic complexes can be formed in which the H_2O layers are replaced by organic layers. Both halloysite and its organic compounds give X-ray photographs similar to those of meta-halloysite, with only the basal reflexions changed, corresponding to an expanded c_0 parameter. The character of the (*hk*) reflexions and the absence of (*hkl*)

reflexions is again indicative of the randomness of orientation of the layers. It appears, therefore, when meta-halloysite is formed from halloysite by low-temperature dehydration, that the H_2O layers are expelled with subsequent collapse of the randomly orientated kaolinitic layers.

The exact values of the basal spacings, (001) and (002), of meta-halloysite appear significant. Naturally occurring specimens give values for d (001) of the order of 7·3–7·5 A., and the line is generally diffuse, mainly on the low angle side; d (002) is about 3·6 A., so that $d\,(001) > 2 \times d\,(002)$. Heat treatment sharpens the (001) line considerably and reduces d (001) almost to 7·2 A.; the (002) line also sharpens slightly but with little change of spacing. This is illustrated in the figure. It is suggested that the kaolinitic layers in meta-halloysite are originally distorted, with some layers more widely spaced than 7·2 A., and that heat treatment causes the layers to 'settle down' into a more regular formation. This may also be correlated with MacEwan's observation that meta-halloysite formed by gentle dehydration of halloysite will combine almost completely with ethylene glycol, whereas after heat treatment this is no longer possible: this probably indicates that with heat treatment the numbers of effective linkages between the kaolinite sheets increases.

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D. M. C. MacEwan.

Macaulay Institute for Soil Research,
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Oct. 18.

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Patterson Distributions and Native Protein Crystallography

Megamolecular crystals such as the crystals of native proteins confront X-ray crystallography with a new situation, since the structure of the molecules is unknown. We suggest that a systematic study of what may be called *the language of structure factors* may be a useful, even a necessary, preliminary to the interpretation of the intensity maps of crystals containing megamolecules of unknown structure. A preliminary study of this nature has therefore been undertaken[1]. The purpose of this note is to describe one by-product of this work which may be of interest in view of the great prominence given to the Patterson diagrams of protein crystals, namely, a method of evaluating the Patterson distribution of a given distribution.

Let $\varrho(x)$ be a distribution in one-dimensional space satisfying appropriate conditions[2]. Then its structure factor is

$$G(X) = \int_{-\infty}^{\infty} e^{2\pi i xX} \varrho(x)dx$$

and

$$\varrho(x) = \int_{-\infty}^{\infty} e^{-2\pi i xX} G(X)dX.$$

Now by definition the Patterson distribution $g_P(x)$ has the structure factor $|G(X)|^2$. Hence

$$g_P(x) = \int_{-\infty}^{\infty} e^{-2\pi i xX} \left|G(X)\right|^2 dX.$$

As an example, let $\varrho(x)$ be 1, ½, 0 according as x^2 is less than, equal to or greater than unity. Then

$$G(X) = \sin 2\pi X/\pi X,$$

and it follows that

$$g_P(x) = \int_{-\infty}^{\infty} e^{-2\pi i xX} \left|G(X)\right|^2 dX$$

$$= 2\int_{0}^{\infty} \cos 2\pi X(\sin 2\pi X/\pi X)^2 dX.$$

Using Dirichlet's discontinuous factor, we find that $g_P(x)$ is confined to the strip for which x^2 is less than 4 and within that range is given by

$$g_P(x) = 2 - |x|.$$

The method may be used also in cases in two- and three-dimensions. We may cite two examples.

Let $\varrho(xyz)$ be a unit distribution confined to a cube volume defined by the planes $x^2 = 1$, $y^2 = 1$, $z^2 = 1$. Then, proceeding after the same manner, its structure factor is

$$G(XYZ) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} e^{2\pi i(xX+yY+zZ)} dxdydz$$

$$= (\sin 2\pi X \sin 2\pi Y \sin 2\pi Z)/\pi^3 XYZ.$$

Now, by definition, the Patterson distribution is given by

$$g_P(xyz) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} e^{-2\pi i(xX+yY+zZ)} \left|G(XYZ)\right|^2 dXdYdZ.$$

Again making use of Dirichlet's discontinuous factor, we find that the Patterson distribution is confined to a similarly situated cube of double the dimensions and is given therein by

$$g_P(xyz) = (2 - |x|)\,(2 - |y|)\,(2 - |z|).$$

Let $\varrho(r)$ be a spherically symmetric distribution. Then its structure factor, also spherically symmetric, is given by

$$G(R) = 4\pi \int_{0}^{\infty} r^2 \varrho(r)\,[\sin 2\pi rR/2\pi rR]dr,$$

as in the case of the atomic scattering factor, for example. The Patterson distribution is then

$$g_P(r) = 4\pi \int_{0}^{\infty} R^2 \left|G(R)\right|^2 [\sin 2\pi rR/2\pi rR]dR.$$

If $\varrho(r) = 1/r$ within the unit sphere and is zero outside it, then

$$G(R) = [1 - \cos 2\pi R]/\pi R^2.$$

The Patterson distribution is then

$$g_P(r) = 4\pi \int_{0}^{\infty} R^2 \left\{\frac{1-\cos 2\pi R}{\pi R^2}\right\}^2 \frac{\sin 2\pi rR}{2\pi rR}\,dR.$$

It follows that $\varrho(r)$ is confined to a sphere of double the dimensions, being given by

$$g_P(r) = \pi(4 - 3r, r - 4 + 4/r)$$

for $r = 0$ to 1 and 1 to 2, respectively. Proceeding in the same way with

$$\varrho(r) = a/r + b + cr + dr^2 \ldots$$

we may study the anatomy of the Patterson distribution corresponding to two or more distributions superposed, analysing it into the terms due to the distributions separately and the terms due to their interactions in pairs. This analysis is of interest in connexion with all native protein crystals which are essentially protein-water systems.

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Total Reflexion in Absorbing Media

It does not appear that the features of total reflexion in the case of two absorbing media have been well introduced into light, particularly a discontinuity which characterizes it, and which may provide a new method of comparing conductivities.

We consider a plane electromagnetic wave incident on a plane boundary between a medium with inductive capacity ε_1, conductivity σ_1, and a medium with ε_2, σ_2. We assume $\mu_1 = \mu_2$. Let the boundary be the $y-z$ plane; let the electric vector be perpendicular to the plane of incidence, and be represented in the two media respectively by:

$$\left.\begin{aligned} E_y^{(1)} &= Ee^{-\sqrt{\varepsilon_1\mu\omega}\{a_1 z + a_2 x + ib_1 z + ib_2 x\} + i\omega t}, \\ E_y^{(2)} &= E''e^{-\sqrt{\varepsilon_2\mu\omega}\{A_1 z + A_2 x + iB_1 z + iB_2 x\} + i\omega t} \\ &\qquad \text{(where } \omega = 2\pi \times \text{frequency).} \end{aligned}\right\} \quad (1)$$

These quantities are connected by the relations:

$$\left.\begin{aligned} b^2 - a^2 &= 1 \quad ; \quad B^2 - A^2 = 1 \quad ; \\ 2\bar{a}.\bar{b} &= \frac{\sigma_1}{\varepsilon_1\omega} = \eta_1 \; ; \quad 2\bar{A}.\bar{B} = \frac{\sigma_2}{\varepsilon_2\omega} = \eta_2 \quad ; \\ A_z &= \sqrt{\frac{\varepsilon_1}{\varepsilon_2}}\,a_z = \frac{a_z}{n} \; ; \quad B_z = \sqrt{\frac{\varepsilon_1}{\varepsilon_2}}\,b_z = \frac{b_z}{n}. \end{aligned}\right\} \quad (2)$$

by means of which, if we assume knowledge of all the parameters of the first medium, and of n and η_2, we find:

$$\left.\begin{aligned} 2n^2B_x^2 &= (n^2 + a_x^2 - b_x^2) + \\ &\quad [(n^2 + a_x^2 - b_x^2)^2 + (n^2\eta_2 - 2a_xb_x)^2]^{1/2} ; \\ 2n^2A_x^2 &= -(n^2 + a_x^2 - b_x^2) + \\ &\quad [n^2 + a_x^2 - b_x^2)^2 + (n^2\eta_2 - 2a_xb_x)^2]^{1/2} . \end{aligned}\right\} \quad (3)$$

The sign of the product $A_x B_x$ is determined by $2\overline{A}.\overline{B} = \eta_2$, but, to find which of the two possible solutions holds, we must impose a further condition, which obviously will be that the amplitude of the reflected wave be not larger than that of the incident wave. In the case under consideration ($\overline{B}$ perpendicular to the plane of incidence) this condition is equivalent to:

$$A_xa_x + B_xb_x \geqslant 0 \quad (4)$$

We shall discuss the case of $\eta_1, \eta_2 \ll 1$, and of planes of equal amplitude coincident with planes of equal phase in the first medium. As we are interested in total reflexion, we shall take $n < 1$. In this particular case (i being the angle of incidence) (3) reduces to:

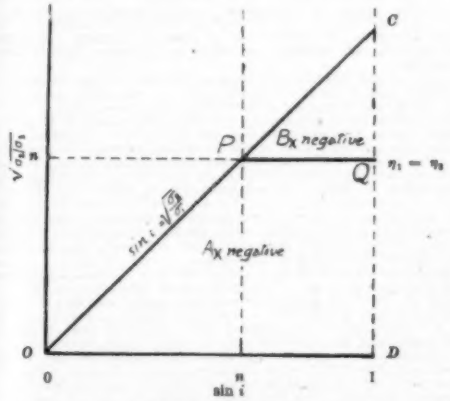
$$\left.\begin{aligned} (\sin i < n)\ B_x &= \sqrt{1 - \frac{\sin^2 i}{n^2}} \quad ; \\ A_x &= \frac{n^2\eta_2 - \eta_1 \sin^2 i}{2n\sqrt{n^2 - \sin^2 i}} \\ (\sin i > n)\ B_x &= \frac{n^2\eta_2 - \eta_1 \sin^2 i}{2n\sqrt{\sin^2 i - n^2}} \quad ; \\ A_x &= \sqrt{\frac{\sin^2 i}{n^2} - 1} \\ &\text{(for } \sin i \text{ not too near } n); \\ (\sin i = n)\ B_x &= |A_x| = \sqrt{\frac{|\eta_2 - \eta_1|}{2}} \quad ; \\ &(A_x \text{ negative if } \eta_2 < \eta_1). \end{aligned}\right\} \quad (5)$$

When $\sin i = \sqrt{\frac{n^2\eta_2}{\eta_1}} = \sqrt{\frac{\sigma_1}{\sigma_2}}$, either A_x or B_x are 0, according as, for this value of i, $\sin i \lesssim n$ (they are both 0 for $\sin i = n$). Both A_x and B_x are positive for $i = 0$. For $\sin i < n$, B_x remains always positive, while for $\sin i > n$ condition (4) gives:

A_x negative, B_x positive for $\eta_1 > \eta_2$;

A_x positive, B_x negative for $\eta_1 < \eta_2$.

(In this particular case the same conditions hold when the electric vector is in the plane of incidence.) For $\eta_1 = \eta_2$ both solutions are admissible, and for both of them the reflexion coefficient is equal to 1. Total reflexion is thus characterized by a discontinuity in the position of the vectors $\overline{A}$ and $\overline{B}$. We may speak of double refraction occurring in the conditions envisaged. The diagram summarizes the state of affairs. A_x is negative in the region $OPQD$, while B_x is negative in the region CPQ, and the discontinuity occurs along PQ, which reduces, for $\eta_1, \eta_2 \to 0$, to the ordinary zone of total reflexion.



In the general case, though the lines of the above diagram may take various forms, the general features are the same, both for the electric vector perpendicular and parallel to the plane of incidence.

In conclusion, I wish to express my gratitude to Prof. H. T. Flint for his interest and co-operation in this problem and to Dr. H. Fröhlich for a discussion.

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Radio-sonde Recording of Potential Gradients

The radio-meteorograph developed by the Bureau of Standards[1] has been modified so as to transmit during its balloon ascent signals indicating the potential gradient in the free air. This gradient has already been investigated in connexion with thunderclouds by Simpson and Scrase using a somewhat limited method[2].

In the original *radio-sonde* transmitter the audio-frequency modulation of the carrier wave is controlled by the variation of the resistance of a temperature- or humidity-element. However, the modulation frequency is also influenced by variation of the grid potential applied to the modulator. This effect is utilized by passing the current due to point discharge in an electrostatic field through a fixed value resistor situated in the grid circuit of the modulator valve.

The receiving equipment is that used in connexion with the *radio-sonde* work as developed by the Bureau of Standards, and consists of a super-regenerative receiver and an electronic frequency-meter the indications of which are automatically recorded. The *radio-sonde* transmitter is located at the centre of the collector wire in order to maintain the balance of the transmitting aerial. With the arrangement used at present (collector length 64 ft.) a field of 3 volts/cm. is required to start the point discharge. The relation between discharge current and change in modulation frequency is approximately linear and the sensitivity of the apparatus may be gauged from the derived graph in Fig. 1.

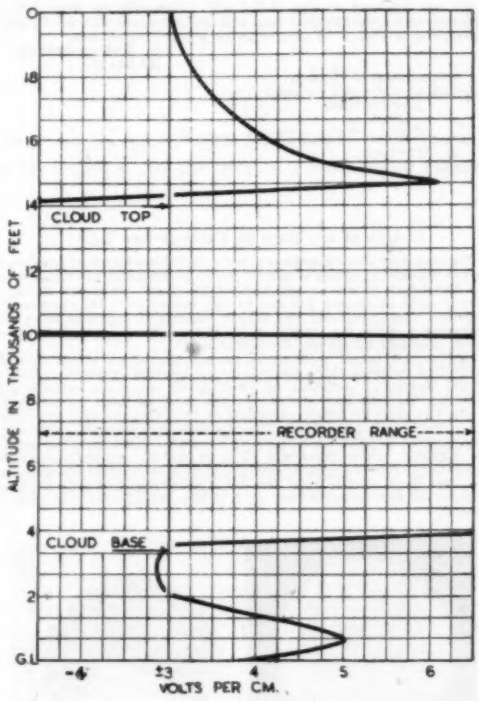

Fig. 1.

This record was obtained by releasing the apparatus beneath an isolated cumulo-nimbus cloud with fracto-stratus formation below. The field at ground-level (positive downwards) was 4 volts/cm. The graph has been smoothed particularly in the lowest negative bulge where probably the fluctuations (positive and negative) correspond to the fracto-stratus region. On entering the cloud the potential increased rapidly to a high positive value (off record); while the balloon is in the cloud, it enters a region where the potential gradient alters very rapidly from a high positive to a high negative value (again off record), remaining at the latter until the balloon emerges from the cloud, when the value changes again to a moderate positive gradient, eventually decreasing. Such a record would be explicable in terms of a cloud with a positive region below and a negative region at the top.

The calibration of the apparatus is readily carried out in the laboratory, but no allowance has been made so far for humidity changes in the atmosphere, affecting *inter alia* the striking potential. The method seems to show considerable promise for the investigations of layers in the lower atmosphere and of the electrical structure of clouds. The sensitivity is adjustable and it is proposed to improve the method and to include the potential gradient with the normal meteorological record.

Fig. 2 shows a reproduction of the upper portion of the actual record, represented in Fig. 1, after the transmitter had traversed the cloud. The scattering of the recorded points indicates the fluctuating manner in which the change of the potential gradient takes place.

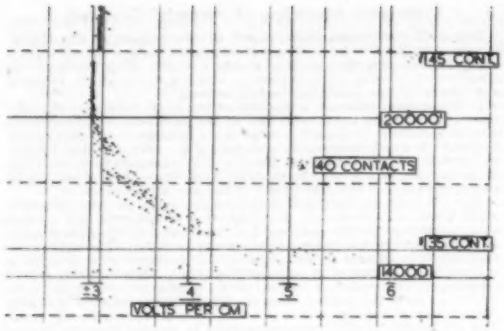

Fig. 2.

We are indebted to the R.N.Z.A.F. Meteorological Branch for materials and meteorological data and for assistance with the balloon flights, and to Prof. P. W. Burbidge for helpful suggestions.

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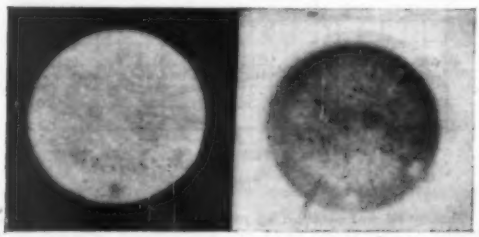
Origin of Ion Burn in Cathode-Ray Tubes

CERTAIN types of cathode-ray tubes in which the luminous spot on the fluorescent screen is moved by magnetic fields are liable to a peculiar defect, known as 'ion spot' or 'ion burn'. It is now thought that in most cases they are due to ions issuing from the thermionic cathode. This conclusion was mainly reached by inference from the composition of the ion stream which was analysed by mass-spectroscopic methods by several investigators[1-3].

Several 'ion burns' were found in this laboratory which showed distinctive patterns corresponding to the electron emission patterns of the thermionic cathodes as observed by using the cathode-ray tubes as 'electron-microscopes' (in the type of tube investigated, this can be done by simply switching off the focus coil and deflecting coil currents, and operating the tube otherwise under normal conditions). This appears to establish a direct experimental proof that 'ion burns' are, although not necessarily in all cases, due to negatively charged ions emitted from the electron emissive parts of the thermionic cathode, and that in particular local 'ion burn' density and specific electron emission of the corresponding part of the cathode may be closely related.



a b

'ION BURN' (*a*) AND ELECTRON IMAGE OF CATHODE (*b*). REDUCED TO 3/5.

A good example of this kind of 'ion burn' is shown by the accompanying photographs. It was observed that in a certain freshly made cathode-ray tube, using magnetic deflexion and magnetic focusing and a tetrode gun system, an 'ion burn' with a distinct pattern seemed to form fairly rapidly when the cathode was overheated for reactivation while the accelerating voltage was left on. In order to intensify the 'ion burn', the tube was operated for three hours with an accelerating voltage of 6 kV. and a beam current of 600 microamp., but running the heater with 9·0 V. instead of 6·3 V. as usual, leaving the focusing coil switched off but a small scan applied to the deflecting coils, so that the pattern of the electron emission image of the cathode was suppressed. After this period the 'ion burn' had become just discernible at the normal accelerating voltage of 6 kV. On lowering the voltage to 1 kV. the 'ion burn' stood out in good contrast on the background of the even illumination of the undamaged part of the fluorescent screen when scanned with a slightly diffuse electron beam. Photograph *a* was taken under these conditions.

The accelerating voltage was then raised again to 6 kV., and focus coil and scan were switched off, leaving all other conditions as during the three hours previous run, so that a magnified electron emission image of the cathode was obtained on the tube screen (photograph *b*). It will be noticed that the marked 'electron emission structure' of the thermionic cathode is reproduced (in negative) by the 'ion burn' except for a few, though perhaps significant, details. For example, the 'ion burn' image contains an additional fairly intense dark spot near the centre which has no counterpart in the 'electron emission' image. Such additional rather intense but small 'ion burns' near the centre of the large main 'ion burn' are frequently observed in magnetically focused cathode ray tubes although their origin appears obscure at present.

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Quenching of Fluorescence by van der Waals Forces

THE quenching of fluorescence of dyes in solutions has been explained satisfactorily as a chemical reaction in a number of cases. In an interesting paper[1] Weiss has classified some different mechanisms of 'chemical' quenching, such as quenching by ions and by the electronegative oxygen molecule[2]. Furthermore, Weiss has attempted to explain the well-known fact of concentration quenching chemically: according to him the formation of dimers is responsible for the decrease of fluorescent efficiency in solutions with increasing concentration of the fluorescing solute. On the other hand, Franck[3] has shown that under certain conditions the electronic energy of an excited dye molecule in solution may serve to form a tautomer by a process of internal conversion. In this way electronic energy is transferred into vibrational energy of nuclei and so the fluorescent efficiency is reduced.

It should be emphasized, however, that the process of quenching in solutions is of a very general nature. The fluorescent yield of anthracene in the solid state is more than 80 per cent, but was shown by Bowen and Norton[4] to be reduced to a fraction of this value in different solvents, chemically inert solvents forming no exception to this rule. One should therefore look for a physical interpretation of the phenomenon which would account for its general validity.

Such an interpretation presents itself when one considers that a fluorescing molecule in a solvent of a very dilute solution interacts with the molecules of the solvent in the same way as they interact with each other. Apart from the thermal energy, this interaction is mainly determined by van der Waals forces, the influence of which manifests itself in both the absorption and fluorescence spectra of the molecule[5]. There is the well-known red shift of these spectra in solution as compared with the gaseous state which is of the order of 10^3 cm.$^{-1}$; secondly, the peak of the longest wave absorption band is separated from the peak of the shortest wave fluorescence band, this (0—0) separation being of the order of 10^3 cm.$^{-1}$; and, finally, there is a broadening of the bands.

Quantitatively, all these three factors run parallel with each other and they can be related to the van der Waals interaction of the fluorescing molecule and the molecules of the solvent. Partly this interaction (in dipole-free liquids) is proportional to the polarizability of the solvent; partly it is determined by the synchronized oscillations induced in one molecule by the changing field due to the time-varying configuration of charges of another molecule. This latter factor is proportional to a term containing a dispersion denominator, and therefore may reach considerable values in case of resonance.

With an experimental arrangement similar to that described by Rollefson and Dodgen[6], and which will be described elsewhere, it was found that quenching of fluorescence is another effect of van der Waals interaction which may be quantitatively related to those mentioned above. Obviously the van der Waals forces, by distorting the normal charge distribution of the molecules, increase the probability of a conversion of the electronic excitation energy of the fluorescing molecule into vibrational energy of its neighbours. According to this explanation, quenching should become more pronounced the closer the main absorption frequency of the solvent approaches the characteristic absorption frequency of the fluorescing molecule. Concentration quenching or self-quenching easily fits into this picture, being the special case of complete resonance, when the excited molecule interacts with molecules of the same kind.

Measurements were made on anthracene (1×10^{-4} mol./l.), in hexane and benzene which were freed from air by distillation *in vacuo* and sealed off; the photographic-photometric method was used for absorption as well as for emission. Only the Hg-lines at 3650 A. which do not excite any of the solvents were allowed to pass through the cells containing the solutions and the pure liquids respectively. As the shortest wave fluorescence band of anthracene was strongly absorbed in the experimental arrangement used, the sum of the intensities of the second and third band was determined and related to the absorbed energies. This is a correct procedure, since it was proved experimentally that the relative intensities of the bands do not depend on the nature of the solvent[7].

The results show that fluorescence of anthracene is quenched in benzene by 35 per cent as compared to the solution in hexane. This is in disagreement with the figures given by Bowen and Norton[4], who found the efficiency in benzene higher than in hexane by about 20 per cent. This discrepancy may possibly be explained by the fact that the anthracene concentrations as used by these authors were 25 times as high as ours. Here self-quenching may already play a part[8], acting more strongly between the anthracene molecules in hexane, the viscosity of which at room temperature is half that of benzene.

Experiments are in progress to examine further the quenching action of van der Waals forces.

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Methyl Iodide Flame Bands

In 1937, Vaidya[1] reported that he had observed in the spectrum of the flame of methyl iodide burning in oxygen, two systems of bands which he described as being degraded to the red, and without any visible fine structure. Thirty-five bands were observed between 4265 A. and 5720 A.

In an endeavour to find out if I—O or C—I were the emitter of these bands[2], we photographed the spectra of electrodeless and normal discharges through the vapours of various organic iodine compounds, and also through mixtures of iodine in oxygen. No new bands were observed. We then repeated Vaidya's experiments on the flame spectra of methyl iodide, under nearly the same conditions as his.

Twenty bands, degraded to the red and having a rotational fine structure, were observed in the wave-length range of Vaidya's bands. There was no marked difference at any point in the rotational structure of these bands, and vibrational analysis showed that they all belonged to the one system, the frequencies (cm.$^{-1}$) of the band heads being given very well by the equation:

$$\tilde{\nu} = 21548{\cdot}5 + [541{\cdot}8\,(v' + \tfrac{1}{2}) - 16\,(v' + \tfrac{1}{2})^2] - [686\,(v'' + \tfrac{1}{2}) - 6{\cdot}5\,(v'' + \tfrac{1}{2})^2].$$

Allowing for the fact that Vaidya's ground-state frequencies are two units (cm.$^{-1}$) less than ours, this equation is practically the same as his for his "B system". In fact it predicts some of Vaidya's bands which we did not observe; for example, Vaidya gives a band head at 5339·7 A., our equation predicts one (1–5 band) at 5334 A. Our values for the wave-lengths of the band heads do not agree very well with Vaidya's; they are in some cases 5 A. different. Our values are the means of six separate estimations, the order of accuracy being ±0·2 A.

Three estimations were made direct from the plate using a comparator (5·76 A./mm.), and three from microphotometer tracings (0·61 A./mm.). The instrument used for photographing the bands was a Hilger E 185 concave grating spectrograph.

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Entropy and Elasticity in Keratin and Myosin

A good deal of attention has been directed lately[1] to the question of rubber-like elasticity in high polymers, and experiments based on thermodynamic arguments have emphasized, in the case of rubber itself, the importance of the contribution of decreasing entropy to the load at high extensions. That high elasticity is not always due to entropy is, however, shown by my results for keratin (Cotswold wool), which confirm what on other grounds has always appeared certain, that the normal elastic mechanism in keratin involves chiefly the internal energy: extensions up to some 20 per cent are accompanied by an increase in entropy; and although at higher extensions the entropy decreases, it is only at a rate which contributes relatively little to the load. Similar results have been reported by Bull[2] for human hair.

The part played by entropy changes in the elastic behaviour of 'generalized' wool[3] (fibres relaxed at high extensions in dilute caustic soda solution and allowed to revert to their initial lengths before washing) is perhaps of greater interest, for such fibres can be made to contract ('supercontract') by treatment with hot water or steam, a phenomenon recalling the thermal contraction shown by many high polymers. I find that when generalized wool fibres which have not been allowed to supercontract are stretched in cold water, the entropy decreases and thus makes a positive contribution to the load. As the extension increases beyond 1 per cent, however, the internal energy contribution rises rapidly, and so far outstrips the entropy effect that the latter is already only some 10 per cent of the total load at 15 per cent extension. Somewhat similar behaviour is shown by fibres supercontracted by amounts up to 20 per cent of the initial length by treatment with warm water. Results for one fibre are shown in Fig. 1; it was stretched in water to the initial length from a length 15 per cent less, and then released. In the complete cycle of extension and contraction there is little or no hysteresis in the entropy effect, and (except perhaps at the very lowest extensions) the total load is greater than the entropy contribution both for stretching and recovery. It is thus unnecessary to invoke the entropy in order to explain the reversible elasticity over this range.

When larger supercontractions have been induced by the action of steam, the entropy effect becomes of greater importance. In Fig. 2 are shown the results for a fibre supercontracted by nearly 40 per cent which was taken through a cycle of extension and contraction in water. It will be seen that during the initial stages of the extension the entire load may be attributed to decreasing entropy; and that during the contraction the internal energy may be regarded as responsible down to about 20 per cent below the initial length, beyond which stage the contraction must be entirely due to the entropy.

This sort of behaviour is not unexpected in the light of our knowledge of the molecular changes accompanying high supercontractions, for X-ray photographs of fibres treated similarly to the one considered here show the presence of a considerable amount of partially disoriented β-keratin. For the fibre of Fig. 1, on the contrary, the X-ray

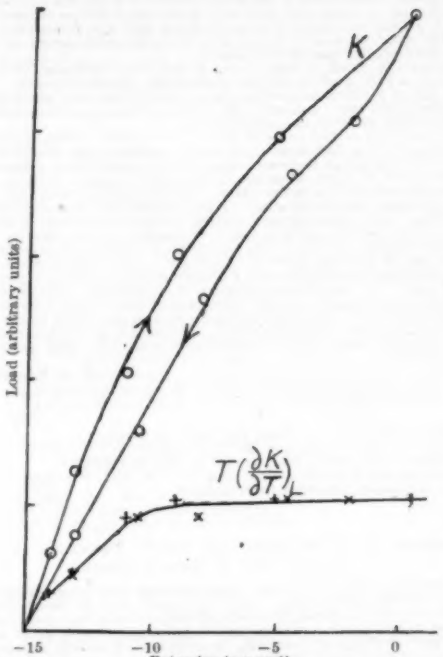

Fig. 1.

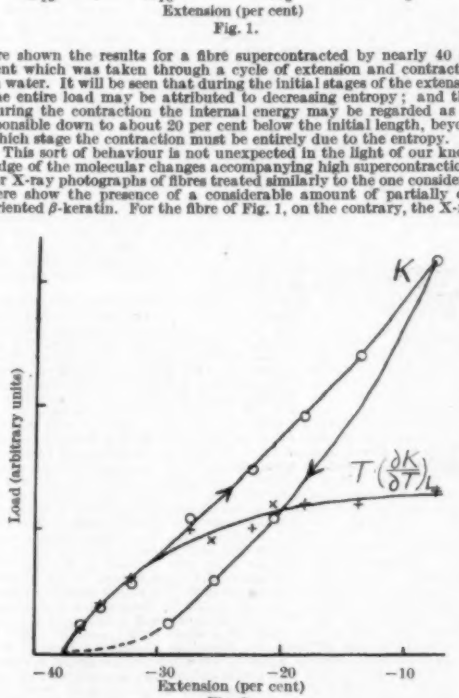

Fig. 2.

FIGS. 1 AND 2. SHOWING THE TOTAL LOAD (K) AND THE ENTROPY CONTRIBUTION (+—+— STRETCHING; ×—×— CONTRACTING) FOR SUPERCONTRACTED WOOL FIBRES IN WATER. THE INTERNAL ENERGY LOAD IS THE DIFFERENCE OF THESE, $(\delta U/\delta L)_T = K - T(\delta K/\delta T)_L$. THE TEMPERATURE RANGE FOR WHICH $(\delta K/\delta T)_L$ WAS OBSERVED WAS 20°–40° C.

photograph would be one of practically normal well-oriented α-keratin, and it must be concluded, both on this account and also because of the relatively unimportant entropy effect, that the mechanism of contraction down to some 20 per cent below the initial length is not one involving random disorientation.

It may be noted in Figs. 1 and 2 that supercontracted keratin exhibits a finite positive entropy effect at the lowest extensions. In this respect it differs from rubber (and, indeed, from most other high polymers) and may be classed with nylon as being more 'rubber-like' than rubber itself at low extensions!

Experiments carried out with films of the muscle protein, myosin, oriented by the technique described by Astbury and Dickinson[4], show that, although the elastic properties of myosin bear a marked resemblance to those of 'generalized' keratin (myosin, however, is even more susceptible to the action of hot water), the entropy effects in normal and supercontracted myosin are more like those in normal keratin: the entropy increases slightly during extensions up to some 20 per cent at least, although there is sometimes to be observed an initial decrease at the lowest extensions, followed by an increase. (The use of the term 'normal' here is not strictly correct, since the experimental procedure is such as to necessitate a certain degree of relaxation. For example, in keratin at low extensions, the total load in these experiments is about 75 per cent of that obtained by quick stretching.) The elastic mechanism in myosin must thus be one involving chiefly the internal energy. The importance of these results in connexion with theories of muscle contraction have been discussed by Astbury[5].

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Presence of a Δ^5-Unsaturated Sterol Derivative in the Medulla Cells of Keratin Fibres

Keratin differs from other scleroproteins in containing a relatively high percentage of sulphur, and it is known that the sensitivity of wool and hair to attack by alkali and alkaline reducing agents results from fission of the cystine disulphide linkages, followed, under more drastic conditions of treatment, by hydrolysis of peptide linkages[1-3]. The medulla of sheep wool and porcupine quill, however, is devoid of cystine[2], while the medulla cells of goat hair resist hydrolysis by 4*N* sodium hydroxide at room temperature, and contain little, if any, sulphur[4]. This observation has been extended to hair from several carnivores and rodents[5-6], and would appear to be a general property of medullary keratin. The X-ray diffraction pattern of medulla cells dissected from Canadian porcupine quill reveals the presence in the cells of β-keratin, together with unidentified material[7]. On X-ray examination, medulla cells isolated from hair by treatment with cold sodium hydroxide showed no spacing corresponding to β-keratin; but a strong meridional arc was found, identical with that from the non-protein constituent of porcupine quill medulla cells[7].

Earlier attempts to identify the non-protein constituent of medulla cells were unsuccessful[8]. More recently, however, experiments using bleached horse hair (South American mane), and fibres from the winter coat of the hare (*Lepus variabilis*), have yielded further information. Fibres were extracted with alcohol, ether and distilled water, and the medulla cells isolated by treatment with 4*N* sodium hydroxide for eighteen hours at room temperature, or by refluxing the fibres with 10 per cent sodium sulphide for two hours, followed by repeated washing with distilled water in a centrifuge tube.

Several drops of an aqueous suspension of the cells were pipetted on to a microscope slide, and one drop of 1 per cent tannic acid added. The cells diminished in size and the surface developed a puckered appearance. When the test was repeated using solutions of 0·1 per cent sodium oleate, or 1 per cent saponin, the cells remained unaltered in size; but the surface became covered with micro-blisters. While the possible occurrence of complicating cell permeability effects must not be overlooked, these results suggest that the surface structure of medulla cells may contain a lipo-protein-cholesterol combination[9].

Rudall's experiments on hair medulla cells[7], together with the fact that, unlike cross-sections of normal fibres, chemically isolated medulla cells do not give a positive diazo-reaction for tyrosine and histidine[6], suggest that considerable modification of the medullary protein occurs during the process of isolation. Furthermore, from the method of isolation, it follows that if the cell wall of isolated cells contains saponifiable lipoid it must be in close association with protein or with non-saponifiable lipoid. The possible occurrence of sterol-protein combinations in blood[9], and yeast[10], together with the statement that ether extraction in a Soxhlet removes only part of the cholesterol from sheep wool[11], suggested that medulla cells may contain a sterol-protein complex. Uncombined cholesterol does not appear to be present, since a chloroform extract of dry medulla cells gave a negative Liebermann-Burchard reaction. In order to test for the presence of combined sterol, medulla cells were heated with an excess of 7·5 per cent alcoholic sodium hydroxide for two hours on a steam bath; a method used by Schoenheimer and Breusch for liberating cholesterol from a wide range of biological tissues. A chloroform extract of the insoluble residue gave a negative reaction with acetic anhydride-concentrated sulphuric acid. Medulla cells were then refluxed for five hours with 10 per cent alcoholic sodium hydroxide, and the residue extracted with chloroform. When tested with the Liebermann-Burchard reagent, the chloroform extract gave a positive colour reaction, thereby showing the presence of a Δ^5-unsaturated sterol, which is very probably cholesterol.

Preliminary tests carried out on the alcoholic sodium hydroxide extract of the medulla cells gave the following results:

On dilution with an equal volume of distilled water a white precipitate was formed. After removing the precipitate, the filtrate gave:

(1) A positive xanthoprotein reaction, a precipitate separating when ammonium hydroxide was added;
(2) Negative reactions to tests for arginine, tyrosine and tryptophane;
(3) A slight precipitate on acidification with hydrochloric acid;
(4) A positive tartaric acid-ammonium molybdate-benzidine reaction for the phosphate radical.

Further experiments are in progress and details will be published elsewhere. I am indebted to Drs. A. E. Alexander, K. M. Rudall and J. H. Schulman for helpful discussion.

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Transplantation of Larval Ovaries in *Drosophila* from and to Individuals Susceptible to Carbon Dioxide

The carbon dioxide susceptibility in *Drosophila*, discovered by L'Héritier and Teissier[1], and apparently inherited in a non-Mendelian manner, shows maternal as well as slight paternal inheritance, and has been tentatively ascribed to a parasite, perhaps a virus[2]. The following experiments were designed to test whether the material basis of susceptibility shows one of the properties of viruses, namely, the ability to be transmitted by grafting. This was done by using the transplantation technique of Ephrussi and Beadle[3].

Larval ovaries from a stock homozygous for the recessive ebony, and showing the carbon dioxide susceptibility, were grafted into female larvæ from a resistant wild-type stock. In a small percentage of cases, those primordia joined up with the genital tract of the host and became functional, either supplanting one of the two ovaries there, or joining the ducts in addition to them. Implanted females never acquired susceptibility. When mated to males homozygous for ebony, but not showing the susceptibility, such females produced offspring of two kinds: phenotypically wild-type flies which were always carbon dioxide resistant, and ebony coloured flies from the implanted ovary, which were always carbon dioxide susceptible. Table 1 shows some numerical results.

Table 1. Number of resistant and carbon dioxide susceptible offspring from 4 crosses between $\frac{+}{+}$ resistant females carrying a functional implanted ovary from an $\frac{e}{e}$ susceptible stock and $\frac{e}{e}$ resistant males.

Resistant		Susceptible	
$\frac{e}{e}$	$\frac{e}{+}$	$\frac{e}{e}$	$\frac{e}{+}$
—	60	44	—
—	81	47	—
—	48	48	—
—	25	38	—

Transplantation of resistant wild-type ovaries into female larvæ from a susceptible stock homozygous for ebony sometimes weakened the susceptibility of the flies emerging. The offspring of crosses between such females and resistant ebony males was again of two phenotypes, ebony and wild. But, whereas the latter were never found to be carbon dioxide susceptible, the former were of two types: they were either composed of resistant and susceptible individuals, or entirely resistant (see Table 2). The cause of susceptibility being lost in the host and her offspring is not yet known.

Table 2. Number of resistant and carbon dioxide susceptible offspring from 4 crosses between females from an $\frac{e}{e}$ carbon dioxide susceptible stock carrying a functional implanted ovary from a $\frac{+}{+}$ resistant stock and $\frac{e}{e}$ resistant males.

Resistant		Susceptible	
$\frac{e}{e}$	$\frac{e}{+}$	$\frac{e}{e}$	$\frac{e}{+}$
9	26	13	—
15	32	21	—
22	24	—	—
33	26	—	—

It might be argued that something which could be called a virus is lacking in the carbon dioxide susceptible stock and present in the normal. This argument, however, is not supported by the outcome of crossing between resistant females and susceptible males, where part of the offspring is susceptible. Furthermore, it has been possible to show that the susceptibility can be destroyed by excessive heat or cold. This would mean that the hypothetical 'virus' characteristic of the normal resistant type can be created at will. This seems very improbable. It seems more likely that there is some agent present in the susceptible flies and absent in the normal flies inhibiting the normal recovery from carbon dioxide narcosis in the former.

The main result of the transplantation experiments has been the demonstration that the material basis of resistance and susceptibility to carbon dioxide does not leave the ovary during the intensive histological changes during the pupal period. It cannot be transferred even under the most favourable conditions. Consequently it is perhaps better described as a plasmagene[4,5] than as a virus, for the time being.

We should like to thank Prof. B. Ephrussi and Dr. A. C. Fabergé for advice on the technique and Miss J. Bathgate for technical assistance during the work.

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Blood Group A Substances in Commercial Hog Stomach Powder

In a search for a convenient source of substances with blood group A specificity, dried hog stomach powder (Boots 'Pepsac') proved suitable. The usual sources, namely, dry gastric mucus and saliva from human secretors, were not readily available.

In a comparison of various methods of isolation, potent preparations were obtained, in small quantities, by ethanol-acetate precipitation, and by precipitation with anhydrous sodium sulphate[1] from watery extracts of the powder. Both methods gave viscous substances which frothed readily, and gave opalescent solutions, even in considerable dilution.

Both preparations contained a protein fraction, giving a pink biuret colour and a positive ninhydrin reaction. The ethanol-acetate substance gave positive xanthoproteic and Millon reactions, while the sodium sulphate substance was but weakly positive with the former and negative with the latter test.

The Molisch reaction was strongly positive with both substances, while both gave a colour characteristic of hexoses and methylpentoses with β-naphthol reagent[2]. Neither preparation had any reducing properties before hydrolysis. The naphtho-resorcinol test for glycuronates was negative (weak green fluorescent ether extract), and the orcin test (Bial) for pentoses was negative. The sodium sulphate preparation gave a very weak pink colour in Tollens test for pentoses, being, however, too faint for satisfactory spectroscopic investigation.

The sodium sulphate preparation was the more potent in inhibition of Group A isoagglutination, being active at dilutions of 1/50,000 of the dry substance. It was some 1·5 times as active as the ethanol-acetate preparation, and fifty times as active as the original powder. In addition, there was inhibition of O agglutination (by an anti-O cattle serum) shown by both substances[3].

Until the deproteinized substances are available in larger amounts, potencies and physico-chemical properties cannot be assessed in absolute terms. The comparison of these and other methods of isolation is in progress, which may also reveal possible effects of manufacturing processes on the potency and characteristics of the specific substance present.

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Addition Compounds between Sucrose and the Sodium Halides

A COMPOUND between sucrose and sodium chloride has been described by a number of investigators, the most complete account being that of Gill[1], who ascribed to it the formula $C_{12}H_{22}O_{11}.NaCl.2H_2O$. Gill also obtained addition compounds with sodium bromide and sodium iodide, to which he ascribed the formulæ $2C_{12}H_{22}O_{11}.2NaBr.3H_2O$ and $2C_{12}H_{22}O_{11}.3NaI.3H_2O$. In the course of an investigation of sucrose by the methods of X-ray crystallography, it became of interest to investigate these compounds more fully.

An aqueous solution of two molecular proportions of sucrose to three of sodium bromide, left to evaporate for a period of months, deposited crystals of the composition shown below:

Sucrose	NaBr	Water (by difference)	
71·3 per cent	21·4 per cent	7·3 per cent	By measurement
71·1 „	21·4 „	7·5 „	By calculation from $C_{12}H_{22}O_{11}.NaBr.2H_2O$

The crystals are orthorhombic, and have the form of prisms with sides parallel to the *c*-axis. X-ray examination shows a unit cell of dimensions: $a = 21{\cdot}9_3$, $b = 9{\cdot}7_1$, $c = 8{\cdot}4_3$ A. The space group is $P2_12_12_1$, the unit cell containing four molecules of sucrose, four of sodium bromide and eight of water. The measured density of the crystals is 1·78, gm./c.c.; calculated from the dimensions of the unit cell it is 1·77 gm./c.c.

The compound between sucrose and sodium chloride has been prepared by slow evaporation of an aqueous solution containing one molecular proportion of sucrose to two of sodium chloride. Crystals of varying composition, from almost pure sugar to pure salt, were deposited, among which a few small crystals of $C_{12}H_{22}O_{11}.NaCl.2H_2O$ were identified by taking X-ray rotation photographs. This compound is isomorphous with that described above. The replacement of bromine by chlorine causes the unit cell to contract by about 2 per cent so that $a = 21{\cdot}7_1$, $b = 9{\cdot}6_3$, $c = 8{\cdot}4_3$ A. The measured density of the crystals is 1·65, gm./c.c. (Maumené[2] erroneously gives it as 1·574).

A compound between sucrose and sodium iodide has been prepared and has been found to be identical with that described by Gill[1] in density, chemical composition and crystallographic form. Unlike the two compounds already described, this substance is very easy to prepare: it crystallizes rapidly from a solution in water of sucrose and sodium iodide in almost any proportions. The approximate dimensions of the monoclinic unit cell are $a = 29{\cdot}4$, $b = 8{\cdot}2$, $c = 8{\cdot}50$ A., $\beta = 94{\cdot}05°$. It thus contains two of the complex molecules $2C_{12}H_{22}O_{11}.3NaI.3H_2O$. The compound $C_{12}H_{22}O_{11}.NaI.2H_2O$, described by Gautier[3] and said by him to be identical in appearance with that described by Gill, has not been obtained by us.

A complete X-ray investigation of the two compounds first described is at present being carried out. The fact that they are isomorphous enables the signs of the structure amplitudes $F(hk0)$, $F(h0l)$, $F(0kl)$ to be fixed, and two-dimensional Fourier synthesis, leading to maps of the electron density projected on the planes (001), (010), (100) can then be carried out. It is anticipated that further work will enable the interesting sucrose structure to be determined.

I am indebted to Dr. C. A. Beevers for facilities to undertake this work.

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Chemistry and Biochemistry of the Scent Glands of the Beaver (*Castor fiber*)

I HAVE just found a short reference in the *Bulletin Analytique* to a preliminary note of P. G. Stevens[1] on "American musk. II. A preliminary note on the scent glands of the beaver", describing the isolation of benzene derivatives. I do not know if more detailed papers have been published since on that subject.

I have been working on the constituents of castoreum, the dried scent glands of the Canadian beaver (*Castor fiber*), since 1940, and have published five papers on that subject in the *Travaux des Membres de la Société de Chimie biologique*. (The Marseilles edition of the *Bull. Soc. Chim. biol.* was published during the occupation without being censored by the Germans; it was not abstracted by the *Chem. Zentralblatt* or apparently by *Chemical Abstracts*.) The first paper[2] describes the isolation of seven aromatic acids: benzoic, hydrocinnamic, salicylic, *m*-oxy-benzoic, *p*-oxy-benzoic, anisic and gentisic acids. The second paper[3] reports the isolation and chemical constitution of two yellow pigments, parents of ellagic acid. The first, $C_{12}H_8O_8$, m.p. above 360°, diacetate F.210°, dimethyl-ether m.p. 151–153°, is a δ-monolactone of a trihydroxy-diphenic acid (probably 4-4'-dihydroxy-diphenyl-methylolide); the second pigment, $C_{14}H_8O_8$, m.p. above 360°, diacetate F.326°, dimethyl-ether m.p. above 350°, is a δ,δ-dilactone of a tetrahydroxy-diphenic acid (hydroxyls probably in 4,4', 6,6'). Both pigments yield fluorene on distillation with zinc dust. The third paper[4] describes the isolation of seven phenols: galacol, creosol, pyrocatechol, hydroquinol, monomethylether of hydroquinol, betuligenol ((-)-*p*-oxyphenyl-butanol-3) (see Sosa[5]) and 2,4'-dihydroxy-diphenyl-methane. The fourth paper[4] reports the isolation of the following aldehydes and ketones: salicylic aldehyde, acetophenone, *p*-oxy-acetophenone, *p*-methoxy-acetophenone, a neutral aromatic methoxy-cetone $C_{10}H_{12}O_3$ and two cetones, $C_{12}H_{16}O_3$ or $C_{13}H_{18}O_3$ (2,4-dinitrophenylhydrazones m.p. 120–122° and 167–169°). The fifth paper[4] describes the isolation of the following substances: benzyl alcohol, borneol, a saturated monocyclic bisecondary glycol $C_{11}H_{24}O_2$ containing one or two CH_3CHOH-groups, cholesterol containing 3·4 per cent of β-cholestanol, a phenolic ether $C_{12}H_{16}O_3$, m.p. 84°, containing the anisyl group and, finally a tertiary amine, castoramine, $C_{19}H_{33}O_2N$, m.p. 65–66°, $[\alpha]D = -31°$, which contains no methoxyl or methylimide group, nor any mobile hydrogen.

I now wish to report the isolation of some more substances which will be described more fully in a future communication. These are: *p*-propyl-phenol, chavicol, ethyl-galacol, methyl-pyrocatechol, ethyl-pyrocatechol, three unidentified phenols (m.p. 135°, $C_{12}H_{18}O_3$, m.p. 145° and m.p. 240°), stearic acid, a fatty acid F.70° (molecular weight 360), cinnamic acid, a hydroxyphenyl-propionic acid m.p. 103–105°, 5-methoxy-salicylic acid, a phenolic acid m.p. 102°, methyl salicylate, a phenolic ester m.p. 170°, cholesterol oleate, a waxy substance, presumably a mixture of esters of 'cerylic alcohol', and a hydrosoluble nitrogen-free substance melting at 173°. We hope to identify some of these substances as soon as micro-analyses will again be feasible. Benzyl alcohol exists in the scent glands in the free form and as neutral and phenolic esters. Gentisic acid and other phenolic acids are present as esters with neutral alcohols and, principally, with other phenols.

The presence of all these substances in an animal gland is very surprising. We believe it to be due to the unusual excretion metabolism of the beaver, which deposits the aromatic substances of its food (mostly bark and buds of trees) in its scent glands, instead of excreting them in the urine. A great number of the above-named substances have indeed been found in the urine of vertebrates. Some substances are deposited unchanged, some after saponification of the glucoside linkage (piceoside → *p*-oxy-acetophenone; betuloside → betuligenol), others after oxidation (salicylic acid → gentisic acid) or

reduction (cinnamic acid → hydrocinnamic acid). The presence of acetophenone, which is rather rare in plant material, may be explained by a mechanism found by Dakin[8] which implies β-oxidation and decarboxylation of hydrocinnamic acid.

The *p*-ethyl-phenol, the principal phenol of the beaver gland, may be derived from tyrosine by deamination and decarboxylation. The great similarity of the constituents of the castoreum with substances frequently found in the urine of vertebrates made us think that the urine of vertebrates might also contain *p*-ethyl-phenol. We distilled the phenols of an industrial extract of hydrolysed pregnant mare's urine and actually isolated 32 gm. of *p*-cresol (see Marshall[9]) and 4·2 gm. of *p*-ethyl-phenol (identified as phenylurethane m.p. 117° and as *p*-ethyl-phenoxyacetic acid, m.p. 95°)[10].

Baumann[11] had already suggested in 1879 the following scheme of degradation of tyrosine by intestinal bacteria: tyrosine → *p*-oxyphenyl-propionic acid → *p*-ethyl-phenol → *p*-oxyphenyl-acetic acid → *p*-cresol *p*-oxybenzoic acid → phenol. All these substances have already been isolated from urine, except *p*-ethyl-phenol.

The *p*-propyl-phenol found in the castoreum may have a similar origin, implying reduction of the carboxyl group of tyrosine; but we have not yet succeeded in isolating it from the phenols of pregnant mare's urine.

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A Substitute for 'Annatto' in Butter

BUTTER—especially that prepared from buffalo milk—is usually artificially coloured to make it look like that afforded by well-known dairy breeds of cows (such as the Jerseys). Many colouring matters for butter are sold under different names, the commonest of which is that known as 'annatto', which is an oil extract of seed coats of *Bixa orellana*. This, as well as many other less common colouring matters, have always been imported into Egypt, but during the War butter makers were forced to prepare butter without artificial colouring matter.

Several trials have been made to cultivate the plant *Bixa orellana* in Egypt, but a good yield will not be expected for many years. It therefore seemed of interest to attempt to prepare, from plant materials available in Egypt, a new colouring extract which may be used as a substitute for 'annatto' and similar colouring matters. A sample of a fresh oil extract of 'annatto' was examined by the tintometer and the proportions of yellow and red colour units determined. Many coloured plant parts containing adequate yellow and red pigments were studied with the aim of finding which of them would provide, either singly or in combination, the proper shade for a new colouring matter. Many organic solvents were also used for the extraction of the colouring matters from the various powdered plant tissues. The results of the extractions and analysis by the Lovibond tintometer showed that none of the plant parts examined could be used singly for the preparation of the proposed colouring extract. It was further shown that one and the same plant part showed different proportions of yellow and red units according to the solvent used as extractant, and also according to the method of drying the plant material before extraction. The best extracts for the preparation of the suggested colouring matter are red peppers (*Capsicum annuum* var. *grossum*) in ether, and the rhizome of *Curcuma tinctoria* in ethyl alcohol. The analysis of the latter extracts by the tintometer enabled us to calculate the exact amounts of both the *Capsicum* fruits and the *Curcuma* rhizome which, when extracted with the appropriate solvents and mixed together, would give the same proportion of yellow and red colour units as that found in 'annatto'.

For the preparation of a sample of this annatto-like colouring matter, 7·5 gm. of dry fruits of red peppers (dried first in the sun and then in an oven at 60° C.) are extracted with ether and the extracted colouring matter is then taken up into 50 c.c. of cotton seed oil. Simultaneously, 6·9 gm. of *Curcuma* rhizome (oven-dried and powdered) are extracted with absolute alcohol and the colouring matter is taken up into 50 c.c. of cotton seed oil. On mixing these two oil extracts thoroughly we get 100 c.c. of a coloured oil which contains yellow and red colour units equivalent to those found in 100 c.c. of oil extract of annatto.

We studied the stability of the suggested extract in lights of different wave-lengths and at different temperatures and found it most stable in red light or in complete darkness. Refrigeration was of too little value to warrant its use for storage of the extract. It may be noted that in ordinary diffused light the yellow and red colour units disappeared more rapidly from the annatto extract than from the substitute colouring oil.

The new colouring extract has been tested and used by the Dairy Department, Faculty of Agriculture, Fouad I University, as well as many dairy firms in Egypt, and has given satisfactory results.

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A Photosensitized Keratitis in Cattle Dosed with Phenothiazine

SINCE the discovery of the anthelmintic properties of phenothiazine, it has been used widely in New Zealand for the treatment of young sheep and cattle.

During the past year there has been brought to our notice, by field veterinarians and inspectors of stock, the occurrence of a number of cases of corneal opacity and temporary blindness in calves a few days after ordinary therapeutic doses of phenothiazine. We have definite records of its occurrence on twenty-five farms; only one or two animals may react, but in one instance every calf in a mob of seventeen was affected. The symptoms observed the day after dosing were profuse lachrymation and sometimes a slight œdematous swelling of the skin around the eye and including the upper eyelid. Between 36 and 60 hours after dosing there appeared, in one or both eyes, a diffuse opacity the position of which was characteristically between the centre of the cornea and its lateral border. There was little loss of appetite, and photophobia, though present, was not very marked. In some animals the lesions disappeared within ten days, but in more severely affected cases a marked œdema of the epithelium and substantia propria developed and ulceration occurred about the fourth or fifth day. Some of these animals still exhibited a slowly resolving lesion after three or four months. Similar ocular lesions have been referred to in accounts of phenothiazine poisoning in pigs[1,2], but there is no record of its occurrence in cattle or other animals.

Experiments to study the condition are in progress at Wallaceville, using young calves as experimental animals. Lesions have been produced in calves dosed with several samples of the drug, with and without added wetting and suspending agents, and of British, American and Australian manufacture. A recrystallized sample gave similar results.

Evidence obtained from field cases and from controlled experiments shows clearly that bright sunlight is necessary for the development of the lesions, although marked signs of photosensitization of the skin are not present. Lesions fail to develop in dull weather or in stalled animals. When one eye is covered by a black velvet shield, lesions do not occur in that eye. Furthermore, the characteristic position of the lesion is on that portion of the cornea which is most exposed to light during grazing. When animals are restrained in a lateral recumbent position, the lesion develops above the centre of the cornea, again the area receiving most sunlight.

Photosensitization by phenothiazine derivatives has been studied in man[3] and in pigs[4], but there is no record of its occurrence in sheep, and negative experimental results were obtained by Swales[5].

Corneal lesions are not a recognized feature of photosensitivity diseases. However, we have produced typical corneal lesions in calves by injecting hæmatoporphyrin into the anterior chamber and afterwards exposing the eyes to sunlight, and similar results were obtained by the injection of phenothiazine derivatives (thionol, phenothiazone, and the leuco phenothiazone conjugate isolated from sheep urine). Derivatives of phenothiazine, not yet definitely identified, have been detected in the aqueous humour and tears of dosed animals, but concentrations were considerably lower than contemporary blood levels.

Corneal opacities and also photosensitization of the shaved skin have been produced in a light-coloured calf dosed with phenothiazine and afterwards exposed to radiation from an impregnated-carbon arc-lamp passing through windowglass and a Wood's-glass filter. From these results it appears likely that the effective radiation lies between 320 and 380 mμ.

A fuller account of the observations recorded above is to be published elsewhere, and further attempts are being made to identify the particular substance responsible.

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[1] Thorning, W. M., Morrill, C. C., and Boley, L. E., *Vet. Med.*, **37** 120 (1942).
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Anopheline Life-Cycles and Population Fluctuations

INVESTIGATION of a population of adult *Anopheles melas* (= *A. gambiæ* var. *melas*), conducted during 1941, showed that their numbers underwent regular fluctuations, with very marked peaks at eight-day intervals, and that the only exceptions to this rule were when the rhythm was broken by the dominating influence of tides[1]. At the time it was difficult to suggest a reason for the fluctuations, because work on both *A. melas* and its close relative *A. gambiæ*, by various people, indicated that the life-cycle must occupy at least ten days. Similar fluctuations were found in an *A. funestus* population at twelve- to fourteen-day intervals, although the supposed time for its complete life-cycle was about twenty days. I tentatively suggested that the fluctuations might be due to intraspecific competition, although this explanation seemed most unlikely.

No. 2 Entomological Field Unit, R.A.M.C., has now conducted investigations in Assam which show that a population of *A. minimus* undergoes regular fluctuations at five- and ten-day intervals, and these fluctuations are only upset by occasional very heavy storms (1–2 in. a day), which delay the peak by one or two days if they occur nine days before the peak is due. Larval investigations, conducted simultaneously, have shown that the life-cycle in Nature at this time occupies ten days, with larval and pupal peak populations which fit and accord with the adult population peaks.

Ten days is a shorter period than that hitherto accepted for the *A. minimus* life-cycle (hatching to pupation only has been said to occupy 9–12 days). It seems likely that the causes of the population fluctuations of *A. melas* and *A. funestus* are the same as those of *A. minimus*, and that the life-cycle of these species, too, is shorter than has hitherto been supposed.

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[1] Ribbands, C. R., *Bull. Ent. Res.*, **35**, 271 (1944).

Erosion in the Sudan

MR. E. N. CORBYN'S recent article headed "Soil Conservation in the Anglo-Egyptian Sudan"[1] is especially significant at the present moment. The appointment of the Committee to inquire into this question was timely. The vital points which are stressed throughout the Committee's Report (which is discussed in Mr. Corbyn's article) are as follows: (1) The absence of trees, shrubs and vegetation. (2) Erosion caused by excessive population. (3) Feeding of cattle. (4) Cutting of wood for fuel.

Twenty pages are devoted to a repetition of the same trouble in each district from one or all of the above causes. It is imperative to ascertain the proportions of the different causes leading to the erosion of the soil—that is, how far human activities are responsible for either actual damage or neglect and how far the cause is beyond the control of human agency. An eminent writer has remarked that the products of Nature can be divided under two heads: those that cannot be reproduced, such as minerals, coal, etc., and those which we can replenish by scientific research and practice. Certainly our forests come under the second heading, and in the past far too little attention has been given to this subject. For many years time and money have been freely expended in scientific research in the best interests of agriculture and for improvements in food products—both quantity and quality; machinery has been devised and discoveries made which have changed barren into fertile land. In some countries—alas, too few!—both in research and practice the same activity has been shown in regard to re-afforestation, but such vigorous action has been rare.

The Sudan covers an area far larger than France and Germany put together, extending about 1,600 miles from extreme north to south and about 950 miles from east to west, part desert and barren land, with scarcely a shrub or tree to be found, and other sparsely covered.

In America in the course of the last ten years or so tremendous changes have been wrought, especially in the Tennessee Valley, where scientific research and practice have been turned to good account for the well-being of the people. One hundred and fifty million seedling trees have been planted on hundreds of thousands of acres of land which was formerly useless, and more than one million acres have been converted into farms of great productivity, thus improving the amenities of the country to such an extent that it has become unrecognizable.

Again, the thrifty French, having an area of some one and three-quarter million acres of land south of Bordeaux which was useless, planted it up with maritime pine (*Pinus pinaster*) and in successive years produced an annual income of more than £500,000.

The traveller approaching Rangoon by sea will notice that the water is so impregnated with sand that supplies of water to the ship are cut off: the Irrawaddy and Salween Rivers are impregnated in the same manner. For more than nine hundred miles the Irrawaddy continues to wash the soil of Burma out to sea. This process has been going on for thousands of years, the two great mountain ranges disintegrating and the conversion into desert hourly proceeding. The Forest Department in 1920 found themselves with more than 100,000 tons of teak trees stranded through the tributary rivers changing their course. Concrete embankments had been built, but were washed away. Mr. F. A. Leete, chief conservator of forests, assisted by Mr. G. C. Cheyne, made a discovery. They found that by driving bamboo sticks into the sand at intervals of about 9 in. apart the river formed its own barrier[2]. By this method great success was achieved: it might be practised far more extensively and perhaps prove a successful barrier to erosion.

Mesquite (*Prosopis juliflora*), one of the finest root-producing trees, has been planted in the Sudan: how extensive this planting has been, or what success has been achieved, the report does not say. The mesquite tree is remarkable for its spreading roots and the manner in which they check erosion of the soil, and it is on record that the roots penetrate to 50 ft. and even as much as 75 ft. beneath the surface of the ground.

No reference is made in the report to any planting of eucalypts. Possibly these have been tried and found unsuccessful, but although their root production is not as good as the Mesquite they have the extra advantage of providing large quantities of fuel wherever they can be grown.

Acacias, making a selection of the particular sort which has the best character for rooting, should be planted, everywhere in abundance, without a moment's loss of time.

At recurring intervals, different peoples in every part of the world have been driven away from their country through the deadly effects of erosion of the soil. Measures have been recommended and laws have been passed to try to combat this, but have either been abandoned or put into force too late to obviate the unfortunate results.

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Nov. 20.

[1] *Nature*, **155**, 70 (1945).
[2] Leete, F. A., and Cheyne, C. C., "Regulation of Rivers Without Embankments" (London: Crosby Lockwood and Son).

The British Commonwealth Scientific Office and Non-Governmental Science

THE recent article by Dr. A. King[1] on the British Commonwealth Scientific Office raises the question of the relations of governmental science and non-governmental men of science. As its executive officer between 1941 and 1944, I am well aware of the services which the Office rendered to the scientific departments of the Ministries, to the Department of Scientific and Industrial Research and to the Medical and Agricultural Research Councils, and I know also that it was always willing to stretch a point and give any assistance within its power to outside bodies and individuals. But its 'extra-curricular' activities were severely circumscribed by its inability to spend funds except on behalf of a Government department. Now that the majority of scientific men are, it is hoped, becoming free, should not this agency serve scientific men and institutions outside the official orbit? Indeed, one might ask if Britain can afford a scientific agency in the United States, at a cost to the Treasury probably equal to the running expenses of several of the major scientific societies together, if it is not to serve all the principal groups of scientific workers.

That many men of science now need such assistance in obtaining their urgent needs from the United States is undoubtedly the case. Perhaps I may be permitted to quote one small example from my own experience. In the course of my work, I wished to obtain a protein preparation recently advertised in American journals. I wrote to the makers and asked for a quotation, stating that I would endeavour to place an order through one of the recognized British wholesalers. They replied that at present they were only supplying it directly to the users. I do not know how the modest dollar expenditure required can be arranged.

I understand there are cases in which university institutions are in urgent need of apparatus from the United States. In some instances it is obtainable without any expenditure of British funds, being a free gift or financed by American grants, but it cannot be imported because the import duty and purchase tax chargeable are prohibitive.

Such difficulties would be readily overcome if the official channels and other facilities were available to universities and similar institutions. Purchases of apparatus and materials in the United States would be greatly assisted if an official body such as the University Grants Committee assigned a certain sum, to be allocated among the universities of Britain in accordance with their needs, and to be used by the British Commonwealth Scientific Office to obtain their requirements in the United States. Unless some such arrangements are made, independent men of science will be at a considerable disadvantage, as long as the present dollar restriction continues.

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Jan. 23.

[1] *Nature*, **157**, 63 (1946).

Academic Scientific Men and Consultants

MAY I be permitted, as a consultant of more than twenty-five years experience, to comment on the leading article in *Nature* of January 26?

It would be a mistake to suppose that consultants are less competent to undertake fundamental research than their academic colleagues; what happens is that the consultant in industry increasingly tends to be preoccupied with day-to-day problems and *ad hoc* investigations, so his attention is apt to be diverted from the pursuit of more abstract knowledge. It is very important that this should not happen to the academic man of science; there needs to be a strict limit to the amount of outside work which he should pursue, despite the pull of finance or industry.

As is so well said in the article in *Nature*, one of the primary functions of the university is to provide research workers for industry; it is agreed that this is best done if the university teachers are themselves active in fundamental research. There is need, too, for the production of those men who will be the consultants of the future, for there are quite a number of branches or subjects in which even to-day there is a shortage, or even complete absence, of skilled persons who are able to undertake work for which there is present industrial demand.

Having a long experience of consulting practice, may I say, too, that it is contrary to experience to argue that as industry pays more attention to research there will be less call for the services of the consultant. It is true that more and more firms set up their own laboratories and research departments (though this name is sometimes inappropriately applied). The effect of this is, however, to increase the demands for outside services of the more specialized kind and to increase the calls on the consultant by other firms. It can be said without fear of contradiction that the calls for consultant facilities have increased—and changed, perhaps—during the last twenty-five years, and are still increasing. I think they will continue to increase; but it is more than ever necessary for the consultant to be himself up to date and of progressive outlook. The methods, equipment and standards of a generation ago are inadequate to-day, and this may involve capital expenditure and expenses on a higher level than of old.

There can be no doubt that the existence of a competent body of independent consultants is of real value to industry, and that suitable persons should be encouraged to launch out into new fields in which there is a shortage. So it is important that such persons should not be subject to competition from State-supported institutions in their ordinary work for individual firms.

It appears to me that academic institutions should not undertake work for which private facilities exist, and that their assistance should be, in the main, for the benefit of industries as a whole rather than for private interests. Most consultants welcome co-operation with their academic colleagues and realize how valuable their aid to industry can be.

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PHYSICAL METHODS FOR THE IDENTIFICATION OF MATERIALS

THE X-ray Analysis Group of the Institute of Physics held a joint meeting with the Midland Branch of the Institute on October 4 in Birmingham, to discuss "Physical Methods for the Identification of Materials". Sir Lawrence Bragg gave a historical summary of different methods which had been used for the identification of materials, and Prof. M. L. E. Oliphant commented on the importance of the subject in nuclear physics. A knowledge of the corrosion products of metals, for example, involves physical methods of identification.

The first paper, by Dr. M. W. Porter and Mr. R. C. Spiller, on the Barker Index[1], dealt with the development of morphological methods. The authors described the development by T. V. Barker of a simplified systematic crystallography which ensures that the surface of a crystal can be (1) unambiguously described in terms of a standard set of axes and parameters derivable from the form development, (2) classified morphologically according to the angular values, (3) identified on any future occasion by the simple process of measurement, geometrical analysis and reference to tables. Precise rules and principles are laid down which transform descriptive crystallography into a determinative science[2]. A crystal is measured in the usual way on a single-circle or two-circle goniometer, a stereographic or gnomonic projection is made and the symmetry is ascertained.

The authors then described how the principle of simple indices is applied to find an unambiguous set of axes and parameters (setting). A correct application of the rules leads independent workers to choose identical settings for crystals of the same substance. Certain angles are then chosen as classification angles and are entered in their proper place in the Barker Index by means of the main classifying angle. Tests have shown that the identification of unknown crystals is then possible. Small crystals generally provide the best reflecting faces for accurate measurement. The ideal size is about 5 mm. × 3 mm. × 3 mm., but crystals as small as 1/10 mm. across can be measured and identified[3]. Two-circle goniometry has the great advantage that small and fragile crystals need only be mounted once or twice for identification.

The present position of the Index is that all the tetragonal and orthorhombic compounds in Groth's "Chemische Krystallographie" have been completed, and crystal descriptions published since Groth are being included. The entries for some of the trigonal, hexagonal and monoclinic and all the anorthic compounds require checking to ensure the greatest possible standard of accuracy. Discussions are now taking place as to the best method of publishing the Index.

In commenting on the Barker method, Dr. M. H. Hey said that it has been overshadowed by the contemporaneous development of X-ray methods, but has its own appropriate field of use. It is better suited to organic compounds, which show few isomorphous series, than to inorganic. It is the only method capable of identifying the original material of pseudomorphs or crystal casts and is quite unaffected by inclusions, however large their amount. It is applicable to metamict materials which show enough external forms. But it fails entirely with fragmentary material, aggregates, felts, spherulites, or other forms lacking crystal faces, and with small crystals having matt or highly curved faces.

The second paper, on optical methods, was given by Dr. N. F. M. Henry. Crystal optics, he said, was developed mainly by mineralogists and petrologists; but chemists are, to an increasing extent, using optical methods in the study both of organic and inorganic substances. These methods are among the most useful in identification work and the application of the polarizing microscope should be the first step, followed by qualitative chemical tests and powder photographs if necessary. In most cases one is working within a limited range of possibilities, and optical methods are often sufficient in themselves, while their rapidity is a great advantage. They are not applicable to extremely fine-grained specimens smaller than 0·001 mm., in which case powder photographs have to be used; but they can be readily used for organic substances, and in this field powder photography is less reliable in general than in the field of inorganic substances.

Measurement of refractive indices is the chief optical method of identification. When a crystal has been immersed in an oil of known refractive index, one or both of two techniques can be used to compare its index with that of the oil. Of these, the Becke line technique is the most sensitive (accurate to ± 0·002) and the more generally useful. The Van der Kolk method is more valuable for crystals and fragments with sloping edges. Other optical properties can usually be recorded as well as the refractive indices and are sometimes indispensable for complete identification. Thus a member of the plagioclase series of felspars can be identified by refractive indices alone, whereas the different forms of asbestos can be suitably identified only by the measurement of extinction angles as well as refractive indices. For these and other simple solid-solution series which have been well studied it is often possible to give an estimate of the chemical composition.

The usefulness of the optical method depends, as with other methods, on the existence of full and accurate data. The latest lists contain some 1,400 minerals, more than 2,000 artificial inorganic substances and about 2,700 organic substances.

Mr. F. A. Bannister opened the afternoon session with a paper on single crystal and powder methods. Of the X-ray methods developed for the analysis of crystal structures, the powder method had predominated and there had been a tendency to neglect single-crystal techniques. This is unavoidable when the crystal size is much less than 0·1 mm., but there are good reasons for using single crystals for identification when they are large enough to be isolated and mounted for a rotation photograph: (1) smaller amounts of a substance can be identified by this than by the powder method[4]; (2) a two-dimensional array of spots on a rotation photograph is a more certain identification than a set of powder lines and can generally be indexed more readily: (3) the deliberate powdering of soft materials like the serpentines, chlorites and many organic substances for identification is not to be recommended, since many of the powder lines obtained will be poorer in definition than the fibre or plate-aggregate photographs which these materials yield in their pristine condition.

Photographs of crystals set up with a principal axis exactly coincident with the axis of rotation are not the only ones which can be used for identification. Rotation or oscillation photographs of unoriented single crystals can often be identified by using a Bernal θx chart or by superposition upon a powder photograph of the same substance. This assumes the

use of the same radiation, camera diameter, pin-hole collimation of the incident X-ray beam and a broader film than is normally used for powder photographs. The method is especially useful for substances with low unit-cell dimensions such as diamond[6] and has been used recently for identifying single-crystal grains of magnetite, goethite and hæmatite in fine-grained bauxites. Single-crystal photographs of a mixture of anhedral grains can be employed to separate each constituent phase for chemical analysis. The value of the method in the determinative mineralogy of the opaque metallic sulphides, arsenides, antimonides and tellurides cannot be exaggerated[6].

Mr. Bannister then described the development of indexes for identification of materials by the powder method. Even when provided with some preliminary optical and chemical data for an unidentified substance, the number of powder photographs of known materials with which comparison is desirable can be large, so that hunting down the right pattern can be time-consuming. System has been introduced into powder determinations by arranging the spacings and intensities of the powder lines of each substance in the form of a card index. The Americans have chosen to index the strongest three lines of each pattern and list the complete powder data on the first of the three cards, that is, the one with the longest spacing. An account of the American index and British co-operation was given by Dr. A. J. C. Wilson at the annual meeting of the X-ray Analysis Group of the Institute of Physics in July 1945[7]. Dr. Wilson has collected, edited and sent to Philadelphia a very large part of the first appendix to the original index[8]. The total number of substances indexed is more than 2,500. This includes more than 700 minerals, nearly 150 organic compounds (excluding acetates, oxalates, etc.), and the rest are inorganic substances including metals and alloys. At a conservative estimate the number of mineral entries has to be doubled and the inorganic field greatly extended. The farthest from completion is the organic section.

It is always desirable to confirm an identification suggested by the powder index with direct comparison of the photograph with a photograph of the substance in question. The interchange of microfilm copies of the powder photographs taken in various laboratories is suggested. The index can often be used to identify three or four components of a mixture. Sometimes a single line will evade recognition when all the rest can be tied down to known components. It is then that one sees the eventual necessity of assigning indices to all the spacings tabulated for a given substance. Otherwise it is impossible to decide whether a weak line additional to those given in the index is due to one of the identified components or to admixture with another substance.

Mr. C. W. Bunn followed with an account of problems of identification in an industrial chemical laboratory. He stated that of the three methods already discussed—morphological, optical and X-ray—only the last two had been used in the laboratory of the Alkali Division of Imperial Chemical Industries, Ltd. Crystals of most specimens submitted are either much too small or not sufficiently well-formed to handle individually by the morphological method. The measurement of refractive indices by the immersion method is widely used, and for direct identification a card index is kept with substances arranged in order of the principal refractive index β. Refractive indices of particles down to 0·001 mm. can be measured, but accuracy falls off with decrease in size of the crystals. Auxiliary evidence of identification is provided by crystal shape and the microscopic determination of the mutual orientation of the principal optical and the morphological directions.

For identification by X-ray diffraction the powder method has been most used. Mr. Bunn said that he uses a 9-cm. diameter camera for most purposes and has been mainly concerned with inorganic substances. The identification of a single substance is usually straightforward, though there are a few cases of different substances having diffraction patterns so closely similar that they might be confused. The constituents of mixtures can often be identified by successive elimination of sets of lines in the pattern; as many as four different crystalline species have been identified in this way[9]. This is usually only possible if they are all present in proportion greater than 10 per cent. Often, after the elimination process, a few faint lines are left which may give suggestions but are not enough to establish identity; here, chemical and physical methods of concentrating constituents may sometimes be employed. For complex mixtures, it is desirable to use a large-radius camera to attain greater resolution; but it may not be possible to get the full benefit from this practice at present, because recorded data are often not sufficiently accurate. For quantitative analyses (two constituents), a powder photograph of the mixture is compared with standard photographs of mixtures of known proportions of the constituents; for rutile-anatase mixtures an answer can be given to $\pm 2\frac{1}{2}$ per cent by visual inspection. For rapid work with familiar mixtures, a small camera ($4\frac{1}{2}$ cm. in diameter) has been used to obtain photographs in fifteen minutes; this is for plant control, where early information of the composition of a mixture enabled adjustments to be made.

With regard to the powder photograph index, the American Society for Testing Materials (A.S.T.M.) index is somewhat unwieldy, with its three cards for each substance. A substance can usually be identified by its strongest line, and Mr. Bunn recommends taking all the 'first' cards out to form a more manageable index, keeping the rest as a reserve. His own index is simpler still: on one card, all substances having their strongest line at a particular spacing (to 0·01 A.) are listed, with references to the complete pattern.

The 'strongest line' procedure, or even the use of the strongest three lines, may not always be successful. Mr. Bunn has sometimes been led to the identification of a constituent by lines at small angles which are not the strongest or even among the first three for the substance in question. They are seen because they are in the region of the photograph where there are no other lines, or very few. For this reason there may be a case for making a supplementary index of 'innermost lines'.

Mr. Bunn concluded with a discussion of the scope of the different crystallographic methods of identification. Of these the X-ray method is by far the most powerful and certain, and in his laboratory there is a tendency to use it straight away. There is now a danger that the microscope may be neglected: this would be a mistake, for where the X-ray method is weakest (in the identification of small proportions of constituents) the microscope method is sometimes helpful. As regards the compilation of data, that must wait on experimental work. When card indexes of optical properties or X-ray powder patterns are

made, the organic substances should be kept separate from the inorganic substances; and further subdivisions may be desirable, so that indexes do not become unwieldy.

Dr. M. Mathieu, of the École de Physique et Chemie, Paris, during a description of studies proceeding in his laboratory, stated that oriented flakes of montmorillonite can contain many 'phases' each with a different water content. Powder photographs, however, would reveal only one simple set of lines. This is characteristic of materials with layer structures and, in particular, clay minerals.

Mr. H. P. Rooksby directed attention to the recent publication of Frevel on the large number of substances in the American Society for Testing Materials index which had as one of the three strong reference lines a spacing between 2·5 and 3 A.[10]. This disadvantage could be removed by a preliminary spectroscopic analysis and a regrouping of the spacing cards under chemical elements. He also pointed out a difficulty which was well illustrated in identifying the components of a refractory containing silica as the major constituent. What the American index would identify as predominantly mullite, a crystalline aluminium silicate, might also contain up to 40 per cent silica-rich glass not revealed by powder photography.

Mrs. Barbara Rogers (Department of Chemical Crystallography, Oxford) said that in the identification of organic compounds they had used single-crystal methods wherever possible, but sometimes, particularly where the preparations were obtained from natural products in small quantities—frequently impure—only powder methods were suitable. In almost all cases they had proved exact enough to discriminate unambiguously between different compounds, even those of essentially similar chemical structure which differ only slightly from each other, as, for example, in the nature of the side chain. Often slight changes in chemical structure are sufficient to produce definite changes in crystal structure and consequently in the appearance of the powder diagrams; even where the two components are practically isomorphous, change in the intensity of the lines can frequently be observed. In certain cases both powder photographs and single-crystal photographs of racemates have proved very similar to those of the optically active components, suggesting that a preliminary examination of synthetic inactive products can often usefully be made before resolution into *d*- and *l*-forms is attempted.

Mr. H. J. Goldschmidt stated that in favourable cases as much as 20 per cent of a second phase might be present in addition to the identified component and yet elude detection by the powder method. He had found that by interrupting a rotation photograph and keeping the sample stationary for the latter half of the exposure, weak lines, due to an additional phase that might otherwise have been missed, were recorded. In this way a trace of ferrite in austenite had been successfully detected. He suggested that, complementary to the American Society for Testing Materials index, a collection of standard minerals and allied synthetic compounds should be prepared and distributed when required by a central organisation.

Dr. K. L. Goodall foreshadowed an important application of the X-ray powder method to the field of industrial health. Fine air-borne dust responsible for silicosis contains constituents which are not yet satisfactorily determined by standard chemical or optical methods. The X-ray technique may well yield quantitative analyses of the small samples of industrial dust being collected by electrostatic precipitation for this study. F. A. BANNISTER.

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J. Sci. Instruments, **22**, 131 (1945).
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MITE-TYPHUS AND THE NEW MITE-TYPHUS VACCINE

MUCH interest has been aroused by the recent release of information about the new vaccine for the protection of man against mite-typhus (scrub-typhus). Mite-typhus has been—and still is—one of the major health risks in the Far East. The name scrub-typhus, which is commonly given to this disease, is somewhat misleading. It was adopted because the disease is prevalent in areas covered with scrub vegetation, which provides a favourable habitat for the larval mite carrying the disease; but experience during the War showed that the disease is just as prevalent, if not more so, in damp areas covered with the very tall tropical *kunai* grass (see J. B. Logue, *U.S. Naval Med. Bull.*, **43**, 645; 1944), which may grow to a height of 10–20 ft., and also in areas where coco-nut palms and other vegetation occur. Damp and swampy country favours the disease. It is found in Japanese river valleys near the sea and for this reason has been called 'Japanese river fever'.

It is clear, therefore, that there is no essential connexion between the disease and scrub vegetation. The essential epidemiological elements are the Rickettsia (*R. orientalis*) which causes the disease, and the larval mite which transmits this Rickettsia to man from small animals, chiefly rodents. The Japanese call the disease *tsutsugamushi* (small-insect) disease. Dutch workers in the Netherlands East Indies (see Kouwehaar and Wolff, *Trop. Dis. Bull.*, **33**, 442; 1936; and van der Schroeff, *ibid.*, **38**, 684; 1941) and some other workers (see C. E. Cook, *Med. J. Australia*, **2**, 539; 1944) consider that larval ticks may also transmit the disease.

Two valuable accounts of mite-typhus have been published, by Sir John Megaw (*Brit. Med. J.*, 109, July 28, 1945) and in a leading article in the *Lancet* (310, March 15, 1945). The *Tropical Diseases Bulletin* and the *Bulletin of War Medicine* also contain abstracts of papers by medical men who have had to deal with outbreaks of mite-typhus in the Far East during the War. Experience of the disease gained there has added considerably to our knowledge of it, for mite-typhus is distributed pretty well all over the Far Eastern theatre of operations, and may be expected to occur also in India and Ceylon. It was known to the Chinese so early as the third century A.D. and was attributed by them to the bite of a small red 'insect'.

Another sound reason for calling this disease mite-typhus and not scrub-typhus is the fact that the name mite-typhus helps to differentiate mite-typhus from the other typhus-like diseases which are also

caused by species of Rickettsia and exhibit similar clinical symptoms. The following notes on these typhus-like diseases are based upon the classification of them given by Sir John Megaw and Sir Leonard Rogers ("Tropical Medicine." London: J. and A. Churchill, 1944). Additional notes have been taken from "Clinical Parasitology" (London: Henry Kimpton, 1943) by F. C. Craig and E. C. Faust.

Sir John Megaw classifies these typhus-like diseases into two main groups:

Group A includes what he calls the *demic* typhus-like diseases, which are transmitted from man to man and not from animals to man. In this group are (1) epidemic or louse-borne typhus, caused by *Rickettsia prowazeki*, which is transmitted from man to man by human lice, especially the body louse (*Pediculus humanus* var. *corporis*). This is the classical epidemic typhus which has caused so much devastation, especially among ill-nourished and disorganized peoples. It broke out in Naples during the winter of 1943–44 and was controlled by destruction of the lice with D.D.T. It is cosmopolitan in distribution. Dr. Knud Stowman, chief of the Epidemiological Information Service of the United Nations Relief and Rehabilitation Administration (*Brit. Med. J.*, 742, May 26, 1945), reports that there are at present three main foci of this disease in south-eastern Europe, namely, Roumania, the sub-Carpathian region and Croatia. Dr. Stowman regards the epidemic in Roumania as being the most serious epidemic of any disease that had occurred during the War. A mild type of typhus-like fever caused by *R. prowazeki* occurs sporadically in New York and is called 'Brill's disease'. Zinsser showed that more than 95 per cent of sufferers from it were immigrants from European districts in which louse-borne typhus is prevalent. Infection with Brill's disease is not known to spread from man to man. Apparently it represents the flaring up of a previous and persistent infection with louse-borne typhus. (2) *Trench fever*, a disease of louse-infested troops transmitted from man to man by human lice. Some workers believe that *Rickettsia quintana* is the cause of it.

Group B includes the *zootic* typhus-like diseases which are also caused by various species of Rickettsia but are transmitted from animals (chiefly rodents) to man and not from man to man. These include the following:

(1) *Flea-typhus* (endemic or murine typhus) caused by *Rickettsia mooseri* and transmitted to man from rats and perhaps also from other rodents by the rat flea, *Xenopsylla cheopis*, and perhaps occasionally by other fleas also. This disease is to be carefully distinguished from demic louse-borne typhus of Group *A*. It occurs in the Mediterranean area, south-eastern United States, Mexico, South Africa, Malaya, Manchuria and the Dutch East Indies, and there are minor foci of it in South America, Russia, China, Australia and India.

(2) *Tick-typhus* caused by *Rickettsia* (*Dermacentroxenus*) *rickettsi*. There are various forms of tick-transmitted typhus-like disease. The classical form of it is the Rocky Mountain spotted fever of the Rocky Mountains and the Pacific coast of the United States, and some of the central and eastern United States. This form of tick-typhus is transmitted by adult ticks, especially *Dermacentor andersoni*. Craig and Faust state that this Rickettsia is primarily a parasite of ticks, which is passed on from tick to tick through both the spermatozoa and the eggs, so that the infection is endemic in the tick and that it is transmitted in Nature to rodents, dogs and man by the bite of the ticks. Other forms of tick-typhus are the so-called *boutonneuse fever* of Tunisia and the Mediterranean area, South African tick-bite fever and similar forms in Kenya, India, South America and Mexico. Various hard-bodied Ixodiid ticks are concerned in the transmission of these fevers, and authorities differ as to the particular species concerned with each form of the disease; but it seems clear that the common dog tick, *Rhipicephalus sanguineus*, transmits boutonneuse fever and that species of *Amblyomma*, *Hemaphysalis* and possibly *Hyalomma* are also incriminated. Experimentally, Rocky Mountain spotted fever has been passed through several generations of the soft-bodied Argasid tick, *Ornithodoros parkeri*.

(3) *Q fever* caused by *Rickettsia burneti*, a mild fever occurring in Queensland and Montana, transmitted from rats to man by *Hæmaphysalis humerosa* and *Rhipicephalus sanguineus* in Australia and by *Dermacentor andersoni* and *Ornithodoros turicata* in Montana.

(4) *Mite-typhus*, caused by *Rickettsia orientalis* (*R. tsutsugamushi*) and transmitted from rats, mice and voles to man by the bite of the larvæ of mites belonging to the genus *Trombidium*. Some workers think that the larvæ of ticks may also transmit it (see above). This Rickettsia persists in the mite from the larva of one generation to that of the next, a period of thirty days. The vectors are *Trombidium akamushi* in Japan and probably also in the Malay States, and probably also *T. deliense* and *T. schüffneri* in Sumatra; the latter two species also parasitize birds, which may therefore also be concerned in the transmission of mite-typhus in areas in which these species of *Trombidium* operate.

The differential diagnosis between these forms of typhus-like fevers is difficult, because they all present similar clinical features. The corresponding problem for the bacteriologist who is seeking to make protective vaccines against them is no less difficult, and it is not made easier by the difficulty of cultivating the Rickettsiæ concerned and in differentiating between them. Diagnosis is aided by the Wilson–Weil–Felix reaction, which utilizes the fact that agglutinins in the blood of the sufferer agglutinate a bacillus (for example, *Proteus OX* 19) which is not related to the Rickettsia causing the typhus-like diseases.

When mite-typhus is contracted, the sufferer often does not notice the bite of the larva of the Trombiid mite, which is only about 0·01 in. long and bites only once in its lifetime. Some 7–21 days later, however, a typical painless ulcer develops at the site of the bite; it is covered with a reddish-black scar (eschar). The symptoms are fever, headache, pains in the loins and limbs, enlargement of the lymphatic glands near the bite or even generally and, on the fourth to the eighth day, a rash, which may be hard to see on sun-tanned or coloured skins. Excitable or stuporose mental symptoms may follow. The sufferer is usually incapacitated for at least three months and as many as 20 per cent may die, although the average mortality is nearer 5 per cent. Much depends, as usual, on the state of nutrition and resistance of the individual. One attack of mite-typhus usually confers immunity which lasts for a variable period.

Until recently, little could be done for sufferers from mite-typhus except efficient nursing and the adoption of vigorous preventive measures directed

against the mites and the rodent (and possibly other) animal reservoirs of the Rickettsiæ. These preventive measures include draining of all camp sites, clearing of vegetation, exclusion of all animals from camps and the impregnation of underclothing with dimethyl phthalate and other repellents. Only very recently has it been possible to publish some information about the work which has been going on in Britain upon the production of a vaccine against "mite-typhus. The *Lancet* (308, Sept. 8, 1945) states that by December 1943, mite-typhus had become a major health risk in the Far East, and that its prevention became an urgent military consideration.

Earlier attempts to make a vaccine by the method of cultivating the Rickettsiæ on the yolk-sac of the hen's egg had failed, but workers at the National Institute for Medical Research at Hampstead found that, when cotton rats were infected with *R. orientalis* through the nose, abundant Rickettsiæ developed in the lungs of the rats. It was found that a killed Rickettsia vaccine gave sufficient protection to mice to justify a trial of the vaccine upon human subjects, and a small field trial in the Far East was planned. Military operations could not, however, await the results of this trial, and the War Office Directorate of Pathology decided to prepare enough vaccine to make possible the simultaneous achievement of two aims—a large-scale field trial and the immunization of as many as possible of the personnel who had to enter infected areas. The work was known as "Operation Tyburn", and by the time it ended on October 31, 1945, 300 litres of vaccine had been made. The project was remarkable for its speed and for the effective co-operation of the many individuals concerned. The organizations most closely concerned were the War Office, the Medical Research Council, the Ministry of Supply, the Wellcome Foundation, Ltd., and the Air Ministry. The flying from America of the cotton rats required must have been a considerable problem for the Air Ministry, but long before this the Ministry had proved its willing co-operation in such matters by flying to England a supply of rats infested with the nematode *Nippostrongylus muris*, which was required for studies of anthelmintics carried out at Cambridge and elsewhere on behalf of the Agricultural Research Council; this parasite is now being used at several English centres.

The cultivation of *Rickettsia tsutsugamushi* in the lungs of cotton rats has been described by F. Fulton and L. Joyner (*Lancet*, 729, Dec. 8, 1945), and the large-scale production of vaccine by F. E. Buckland *et al.* (*ibid.*, 734).

Many different volunteers undertook the considerable risks of working with the mite-typhus vaccine; they included Army medical officers, research workers, soldiers and A.T.S. women. Great credit is due to these workers, for they accepted risks no less than those which were being faced by the forces in the Far East. No doubt much more will soon be known about this remarkable piece of work. It will take its place among those achievements of planned research which will, one hopes, receive in the history of the War the praise which they deserve. Meanwhile it is good to know that some thousands of personnel in the Far East have already been immunized against mite-typhus and, although the results of this trial of the new vaccine are naturally not yet fully known, its successful production will certainly aid our future work on the whole group of the difficult and important typhus-like diseases.

G. LAPAGE.

BIOLOGICAL PROPERTIES OF *BACILLUS SUBTILIS**

By DR. H.-R. OLIVIER

B. SUBTILIS secretes an amylosucrase (B.H. fructosidase), a proteinase which liquifies gelatine or coagulated serum, and a penicillinase. Moreover, it has marked antimicrobic properties. Nicolle, in 1907, first demonstrated its bacteriolytic powers, most pronounced for the pneumococcus, less so for *B. mallei*, *B. pestis*, *B. typhosus*, *B. anthracis* and *Vibrio choleræ*.

In collaboration with L. de Saint-Rat, P. Bonet-Maury and E. Blanchon, we have verified and elaborated on these original ideas. *B. subtilis* acts on the majority of pathogenic organisms, producing complete lysis in varying lengths of time. Lysis is complete with pneumococcus, staphylococcus and streptococcus in forty-eight hours, with typhoid and paratyphoid bacilli in five days, with *B. coli* and *B. tuberculosis* in eight to twelve days.

In demonstrating lysis of *B. tuberculosis* we have used the strain of Arloing and Courmont. This strain of the tubercle bacillus gives, in six days, a definite appearance in the culture medium. At this time *B. subtilis* is sown. At the end of forty-eight hours a thin growth appears, and becomes wrinkled four days after the sowing. Eight days after the start of the experiment the medium clears at the point of contact with the growth of *B. subtilis*; then the clearing progresses and, at the twelfth day, lysis of *B. tuberculosis* is complete. If, at this time, the culture is centrifuged for one hour at 4,000 r.p.m., no trace of acid- or alcohol-fast bacilli or granules is found. Bacteriolysis by *B. subtilis* is, in fact, a general phenomenon.

Apart from its properties of lysis, *B. subtilis* has anti-microbic powers; that is, it opposes the proliferation of micro-organisms. This power cannot be shown on rapidly growing micro-organisms such as *B. coli* or staphylococcus because the active substance is endogenous and is only liberated after lysis of *B. subtilis*; but on the slowly growing *B. tuberculosis* it is clearly seen. Thus, if one sows at the same time *B. subtilis* and the bacillus of Arloing and Courmont, the medium stays clear, and *B. tuberculosis* does not develop. That is why a filtrate of a young culture of *B. subtilis* has neither lytic nor anti-microbic powers on other micro-organisms *in vitro*.

On the contrary, extracts of bacillary bodies with ether or chloroform in acid medium *p*H 2·5, redissolved in aqueous alkaline solution *p*H 8·5, are active against staphylococcus, *B. coli* and the *B. tuberculosis* of Arloing and Courmont.

The biological properties of *B. subtilis* have clinical applications, and it was indeed after successful experiments on the therapeutic effects of living *B. subtilis* given by the mouth in cases of diarrhœa and urinary infections due to *B. coli* that we have been led to study the experimental attributes here described.

Therapeutic possibilities are suggested by an experiment on mice infected with *B. typhi murium*. Two groups, *A* and *B*, of ten mice each, were infected with the Institut Pasteur strain. Group *A* was used as control; group *B* received *B. subtilis* with its food. At the tenth day of the experiment there remained in the control group *A* only one living mouse; in group *B* there were six living. At the

* Translated from the article in *J. des Praticiens*, 187, Aug. 30, 1945.

fifteenth day, there was one living mouse in group *A* and five in group *B*.

To be conclusive this experiment should have been on a greater number of animals, but the necessary material is not procurable at present. We draw no conclusions, but publish this only to demonstrate possibilities in the biological study of *B. subtilis*.

LIMNOLOGY IN THE U.S.S.R.

CONSIDERABLE progress has been made in the U.S.S.R. in the study of lakes and inland seas, especially since 1928, at which date several new limnological stations and institutes were founded and a new method of complex study inaugurated. The essentials of this method consist in team-work combining the study of hydrology, hydrobiology, hydrogeology and hydrochemistry. A short report by L. S. Berg (*Bull. Acad. Sci. URSS.*, Sér. Géol., No. 1, 54; 1945) presents a general review of the work done since 1928, while D. N. Taliev (*ibid.*, 79) presents a report on the activity of the Baikal Limnological Station, and N. M. Strakhov (*ibid.*, 61) discusses the significance of lake and lagoon deposits in the study of processes of sedimentation. The Caspian Sea has been intensively studied by special expeditions, and the work on salt deposits of Kara-Bogaz, begun long ago, has been continued with great success. The salt deposits of Kara-Bogaz are of great interest from the point of view of pure science and have also great industrial value. A number of papers are devoted to the study of the variation of the level of the Caspian Sea during the last seven hundred years. The Aral Sea has also been studied by the Aral Fisheries Station and the Aral Hydrological Institute.

Baikal, the deepest lake in the world, which contains a very interesting relict fauna, was studied by the members of the Baikal Limnological Station founded in 1928 and directed by G. Y. Vereschagin (1889–1944), one of the most prominent limnologists in the U.S.S.R. The endemic fauna and flora of Baikal were studied in conjunction with fossil types found in the sedimentary rocks in the district. This work is considered to be of high importance not only in connexion with limnology but also as a valuable contribution to the theory of evolution.

Another lake intensively studied is Sevan (Gokcha) in Armenia, and eighteen volumes of the "Materials for the Study of Lake Sevan and its Basin" (1931–38) have been published, including reports on the limnology, geology and geography.

Other large lakes such as Balkhash, Issyk-Kul, Ladoga, Onega and a host of smaller lakes (including 1,324 lakes in the Leningrad district) have been surveyed.

Great progress has also been made in the investigation of salt lakes by the Salt Laboratory, the Institute of Halourgy and the Institute of Applied Chemistry. Lake deposits, especially medicinal oozes and sapropelic deposits, have received a great deal of attention and the results published in various periodicals, such as the *Trav. Sapropelic Inst.*, *Microbiology* and others.

Reviews of current literature on limnology are published in the *Bibliography on Hydrology* and in the publications of the Hydrological Institute.

A separate article by N. M. Strakhov is of a particular interest to geologists, for in it the author discusses the mode of precipitation of carbonates in lake waters as influenced by the concentration of various ions, the formation of bauxitic and manganese deposits and the formation of petroleum. In Lake Balkhash, for example, the magnesium carbonate is precipitated in the form of dolomitic ooze at *p*H above 8·8. Contrasted with this are the lakes of the humid zone with a much lower *p*H, in which the carbonates are not precipitated. This, in its turn, influences the process of diagenesis of organic matter, and it is suggested that the formation of petroleum may be conditioned by the alkaline environment in the lakes and lagoons of the arid zone, while the formation of humic material is a characteristic feature of the acid waters in the humid zone.

S. I. TOMKEIEFF.

CLASSIFICATION OF MAMMALS

BY his wide researches on the mammalia, Dr. G. G. Simpson can speak with great authority on their classification, and in a recent paper entitled "The Principles of Classification and the Classification of Mammals" (*Bull. Amer. Mus. Nat. Hist.*, 85; 1945) he gives his views not only on the mammals but, as well, on the wider aspects of classification.

The work is divided into three parts. The first is on general principles and deals with phylogeny, classification and nomenclature. This section is of interest not to students of the mammalia alone but also to all biologists. To use the author's own words, "Taxonomy is at the same time the most elementary and the most inclusive part of zoology, most elementary because animals cannot be discussed or treated in a scientific way until some taxonomy has been achieved, and most inclusive because taxonomy in its various guises and branches eventually gathers together, utilizes, summarizes, and implements everything that is known about animals, whether morphological, physiological, psychological, or geological". This truth has not always been sufficiently recognized.

Under the heading phylogeny the subjects treated are: phylogeny and classification, nomenclature, types and other relevant matters. Thirty pages in double column are taken up by the author's opinions on these, which are clear, concise and most informative.

Part 2 is a classification of the mammalia, living and extinct, headed by a short introduction and explanation of the method used. It is interesting to note in passing the tabular list comparing the numbers of living and extinct genera of the orders of mammals. In general, the number of extinct genera is largely in excess of the living, the Artiodactyla, for example, being as 333 to 86 and the Perissodactyla as 152 to 6. The rodents, on the other hand, reverse the picture, the numbers being 275 to 344 and the Chiroptera 16 to 118. These figures are not without significance and point to these two groups being on the upgrade, though some correction must be made to allow for the lesser chance of preservation as fossils of the smaller kind of animals.

The classification is presented in great detail, complete down to genera living and extinct, together with their distribution in time and space.

Part 3 is a review of the mammalian classification, explanatory of the list given in Part 2 and to be regarded, in the author's own words, as an "elaborate footnote" to it. The orders are discussed seriatim, and various divergencies of opinion of detail in classification reviewed. A bibliography of works referred to in the text, an index of family and generic names and one of vernacular names complete this most valuable work.

C. FORSTER COOPER.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, February 25

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. K. Berry: "Modern Textile Fibres (Cellulose Acetate, Cuprammonium, Viscose, Nylon. Protein, Vinyon, Glass, etc.)", 2: "The Chemical and Physical Properties of Modern Textile Fibres" (Cantor Lecture).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Inaugural Meeting. Mr. A. B. Turner: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Practical Experience of Arc-Suppression Coils" (to be opened by Mr. H. Willott Taylor).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting.

Tuesday, February 26

ROYAL SOCIETY OF MEDICINE (joint meeting with the SCIENTIFIC FILM ASSOCIATION, at 1 Wimpole Street, London, W.1), at 2.15 p.m.—Discussion on "The Place of Films in Medical Education".

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. A. H. Chaplin: "The Principles of Alphabetical Arrangement"; Mr. W. John Merrick: "An Industrial Information Department".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at the Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—"Application of Physico-Chemical Methods to Soil and Crop Studies".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Comparison of Electrostatic and Magnetic Deflection in Cathode-Ray Tubes" (to be opened by Mr. V. A. Stanley and Mr. E. W. Bull).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Papers and discussion on "Chromatographic Analysis".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Mr. J. E. O'Brien: "The Effect of Design of Boiler Auxiliaries on the Choice and Performance of Automatic Control".

Tuesday, February 26—Wednesday, February 27

BRITISH SOCIETY OF ANIMAL PRODUCTION (in the Queen Mary Hall, Y.W.C.A. Central Club, Great Russell Street, London, W.C.1).

Tuesday, February 26

At 11 a.m.—Discussion on "Breeding Methods in Livestock Improvement". (Mr. M. S. Pease and Dr. A. W. Greenwood: "Poultry"; Dr. J. E. Nichols: "Larger Stock".)

Wednesday, February 27

At 10.30 a.m.—Discussion on "Artificial Insemination". (Mr. H. Twinch: "Progress in other Countries"; "Organisation and Administration of Centres"; "Semen Collection and Storage"; "Bull Fertility and Management".)

Wednesday, February 27

INSTITUTE OF FUEL, MIDLANDS SECTION (at the James Watt Memorial Institute, Birmingham), at 2.30 p.m.—Sir Alfred Egerton, F.R.S.: "Production and Utilisation of Methane".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. Major Greenwood, F.R.S.: "The Statistical Study of Infectious Diseases".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. R. F. Tylecote: "The Pressure Welding of Light Alloys".

THE POLYTECHNIC (in the Fyvie Hall, The Polytechnic, Regent Street, London, W.1), at 6.30 p.m.—Mr. C. C. Buckle: "The Film To-day", 2: "The Film 'Talks'".*

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. C. J. T. Cronshaw: "What Industry Expects from the Chemist".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Place of Science in U.N.E.S.C.O." (Speakers: Dr. J. S. Huxley, F.R.S., Mr. J. G. Crowther and Mr. L. G. Grimmett).

Thursday, February 28

IMPERIAL INSTITUTE (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p.m.—Mr. E. S. Willbourn: "Recent Progress in Geological Investigation and Mineral Developments in the Colonies", 3: "The Relationship of the Geological Survey Department to the Mining Industry of Malaya".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., F.R.S.: "Chemical Transmitters of the Effects of Nervous Impulses", 1: "Voluntary and Involuntary Nerves; Alkaloids which Reproduce or Paralyse their Actions—Nicotine, Curarine, Muscarine, Atropine".

BRITISH ASSOCIATION OF CHEMISTS, NOTTS. AND DERBY SECTION (at the School of Art, Green Lane, Derby), at 7 p.m.—Prof. J. B. Speakman: "Some Methods of Making Wool Unshrinkable".

Friday, March 1

PHYSICAL SOCIETY, OPTICAL GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 3 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. Hartridge, F.R.S.: "Acoustic Control of the Flight of Bats".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting. Mr. A. S. Kennard: "Fifty and One Years of the Geologists' Association" (Presidential Address).

PHOTOMICROGRAPHIC SOCIETY (at St. Martin's School of Art, 100 Charing Cross Road, London, W.C.2), at 7 p.m.—Mr. W. E. Watson-Baker: "Microscope Design".

Saturday, March 2

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1)—Conference on "Nutrition in Colonial Territories". At 11.15 a.m.—Dr. B. S. Platt: "The Problem and the Principles Underlying its Solution"; at 2 p.m.—Dr. H. S. Stannus: "Malnutrition in Colonial Territories"; at 2.25 p.m.—Dr. N. C. Wright: "Relation of Animal Husbandry to Human Nutritional Needs"; at 2.50 p.m.—Dr. Audrey I. Richards: "Sociological Factors".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE TEXTILES DEPARTMENT of the Huddersfield Technical College—The Director of Education, Education Offices, Huddersfield (March 2).

AGRICULTURAL ASSISTANT EDUCATION OFFICER—The Chief Education Officer, County Education Office, Stracey Road, Norwich, endorsed 'Agricultural Assistant Education Officer' (March 2).

BIOCHEMIST (graduate) with some research experience and knowledge of biological assay of the vitamins—The Head of the Nutrition Department, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1 (March 2).

LECTURER IN GEOGRAPHY (Honours Degree of a British University and training in teaching essential) at Avery Hill Training College—The Principal, Avery Hill Training College, at Sandy Mount, Crosland Moor, Huddersfield (March 9).

LECTURER IN GEOGRAPHY—The Registrar, Loughborough College, Loughborough (March 10).

KEEPER OF BIOLOGY in the City Museum—The Town Clerk, Room 57, Civic Hall, Leeds 1, endorsed 'Keeper of Biology' (March 11).

LECTURER IN PHYSIOLOGY, and a DEMONSTRATOR IN PHYSIOLOGY—The Dean of the Medical School, St. Thomas's Hospital, London, S.E.1 (March 27).

LECTURER IN MATHEMATICS (Statistics) in the Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (March 30).

LECTURER IN CIVIL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (March 30).

LECTURER IN MATHEMATICS in University College, Dundee—The Secretary, The University, St. Andrews (March 30).

PRINCIPAL OF THE SCHOOL OF MINES—The Secretary to the Governors, School of Metalliferous Mining, Camborne, Cornwall (March 31).

RESEARCH ASSISTANT IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds (March 31).

LECTURER IN BIOLOGY (Honours Degree essential) in the Denbighshire Technical College—The Director of Education, Education Offices, Ruthin (April 9).

UNIVERSITY READERSHIP IN PSYCHOLOGY in the Faculty of Education—The Registrar, University Office, 46 North Bailey, Durham (April 30).

LECTURER IN GEOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (April 30).

READERSHIP IN PHARMACOLOGY tenable at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

SENIOR LECTURER IN BIOCHEMISTRY, and an ASSISTANT LECTURER (grade III)—The Registrar, The University, Liverpool (May 15).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (May 24).

LECTURER (ungraded) IN BOTANY, and a DEMONSTRATOR (part-time) IN BOTANY—The Registrar, The University, Liverpool (June 1).

LECTURER IN INDIAN PHILOSOPHY AND SANSKRIT, a LECTURER IN HINDI, and a LECTURER IN SANSKRIT—The Secretary, University School of Oriental and African Studies, London, W.C.1 (June 14).

LECTURER, and an ASSISTANT LECTURER, IN PHYSICS—The Secretary, King's College, Strand, London, W.C.2 (June 30).

LECTURER (full-time) IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN BIOLOGY AND HORTICULTURE—The Principal, Training College for Women, Lincoln.

LABORATORY TECHNICIAN to assist in work involving the chemical estimation of vitamins—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

PRINCIPAL FOR BIRLA ENGINEERING COLLEGE (Electrical and Mechanical)—The Secretary, Birla Education Trust, Pilani, Jaipur, India (by air-mail).

LECTURER, and an ASSISTANT (Medical Statistics), IN THE DEPARTMENT OF PUBLIC HEALTH AND SOCIAL MEDICINE—The Secretary, The University, Edinburgh.

HEAD OF THE PHYSICS DIVISION—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Manchester.